INTERNATIONAL CIVIL AVIATION ORGANIZATION
ORGANISATION DE L'AVIATION CIVILE INTERNATIONALE
ORGANIZACIÓN DE AVIACIÓN CIVIL INTERNACIONAL
МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ГРАЖДАНСКОЙ АВИАЦИИ
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Ref.: AN 7/1.3.81-00/70

12 July 2000

Subject: Proposal for the amendment of Annex 10 concerning Standards and Recommended Practices (SARPs) relating to the very high frequency (VHF) digital links, alternative provisions for aeronautical mobile-satellite (route) service (AMS(R)S), updates of references to the International Telecommunication Union (ITU) Radio Regulations and digital voice switching and signalling

Action required: Comments to reach Montreal by 12 October 2000

Sir/Madam,

1. I have the honour to inform you that the Air Navigation Commission, at the eleventh meeting of its 154th Session, held on 15 June 2000, considered a proposal developed by the seventh meeting of the Aeronautical Mobile Communications Panel (AMCP) to amend Standards and Recommended Practices (SARPs) in Annex 10 — *Aeronautical Telecommunications.*

2. The proposed amendment to SARPs at Attachment A to this letter is to update the references to the International Telecommunication Union (ITU) Radio Regulations that are contained in Annex 10, taking into account the current numbering scheme of the Radio Regulations. This amendment is of an editorial nature and affects all volumes of Annex 10.

3. The proposed amendment to SARPs at Attachment B to this letter contains the following changes:

a) introduction of provisions for an integrated voice and data link system, recommended by the Special Communications/Operations Divisional Meeting (1995) (SP COM/OPS/95) (VDL Mode 3);

b) introduction of provisions for a data link satisfying surveillance applications as recommended by the SP COM/OPS/95 (VDL Mode 4);

c) deletion of all the provisions for VDL Mode 1, as no plans for implementation of Mode 1 exist and implementation of VDL Mode 2 is imminent; and

d) removal of the detailed technical specifications for Mode 2, which are deemed appropriate for publication in a separate ICAO manual on VDL Mode 2 (see below).

4. Detailed technical specifications supplementing the amendments indicated above will be published as *Manuals on VDL Mode 2, VDL Mode 3 and VDL Mode 4 Technical Specifications*. Copies of the current draft versions of those documents are available upon request.

5. The proposed amendment to SARPs at Attachment C to this letter introduces new provisions for AMS(R)S, as an alternative to those already in existence and contained in Volume III, Part I, Chapter 4.

6. The proposed amendment to SARPs at Attachment D to this letter is a consequential change to the existing AMSS SARPs, clarifying the Standards applicable to geostationary satellite systems after the introduction of the new provisions in Attachment C.

7. The proposed amendment to SARPs at Attachment E updates the provisions on utilization of the VHF bands to accommodate the introduction of VDL Mode 3 (Attachment B refers).

8. At the same meeting, the Air Navigation Commission also considered a proposal developed with the assistance of the ATS Voice Switching and Signalling Study Group (AVSSSG) to amend Standards and Recommended Practices (SARPs) in Annex 10 — *Aeronautical Telecommunications*, Volume III — *Communication Systems,* Part II — *Voice Communication Systems*.

9. The proposed amendment to SARPs at Attachment F to this letter updates the provisions relating to aeronautical speech circuits, taking into account technological advances in digital voice switching and signalling systems.

10. Detailed technical specifications supplementing the amendment in Attachment F will be published as the *Manual on ATS Ground Voice Networks*. Copies of the current draft version of this document are available upon request.

11. The Air Navigation Commission carried out a preliminary review of the proposals and agreed that they should be submitted to Contracting States and international organizations for comments.

12. May I request that any comments you may wish to make on the amendment proposals be dispatched to reach me not later than 12 October 2000. The Air Navigation Commission has asked me to specifically indicate that comments received after the due date may not be considered by the Commission and the Council. In this connection, should you anticipate a delay in the receipt of your reply, please let me know in advance of the due date.

13. For your information, the proposed amendment to Annex 10 is envisaged for applicability on 1 November 2001. Any comments you may have thereon would be appreciated.

14. The subsequent work of the Air Navigation Commission and the Council would be greatly facilitated by specific statements on the acceptability or otherwise of the proposal. Please note that, for the review of your comments by the Air Navigation Commission and the Council, replies are normally classified as "agreement with or without comments", "disagreement with or without comments" or "no indication of position". If in your reply the expressions "no objections" or "no comments" are used, they will be taken to mean "agreement without comment" and "no indication of position", respectively.

Accept, Sir/Madam, the assurances of my highest consideration.

for R.C. Costa Pereira
Secretary General

Enclosures:

Attachment A — Proposed amendment to Annex 10, all volumes (References to Radio Regulations)

Attachment B — Proposed amendment to Annex 10, Volume III, Part I, Chapter 6 (VDL Modes 1, 2, 3 and 4)

Attachment C — Proposed amendment to Annex 10, Volume III, Part I, Chapter 12 (AMSS; alternative provisions)

Attachment D — Proposed amendment to Annex 10, Volume III, Part I, Chapter 4 (AMSS)

Attachment E — Proposed amendment to Annex 10, Volume V, Chapter 4 (Channel labelling VDL Mode 3)

Attachment F — Proposed amendment to Annex 10, Volume III, Part II, Chapter 4 (ATS speech circuits)

ATTACHMENT A to State letter AN 7/1.3.81-00/70

PROPOSED AMENDMENT TO ANNEX 10, VOLUMES I, II, III, IV AND V

(REFERENCES TO RADIO REGULATIONS)

NOTES ON THE PRESENTATION OF THE AMENDMENT TO ANNEX 10

The text of the amendment is arranged to show deleted text with a line through it and new text highlighted with grey shading, as shown below:

1. ~~Text to be deleted is shown with a line through it.~~	text to be deleted
2. New text to be inserted is highlighted with grey shading.	new text to be inserted
3. ~~Text to be deleted is shown with a line through it~~ followed by the replacement text which is highlighted with grey shading.	new text to replace existing text

INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

AERONAUTICAL TELECOMMUNICATIONS

ANNEX 10
TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

VOLUME I
(RADIO NAVIGATION AIDS)

Note 1.— All references to "Radio Regulations" are to the Radio Regulations published by the International Telecommunication Union. Radio Regulations are amended from time to time by the decisions embodied in the Final Acts of World Radio Conferences held nominally each two years. Further information on the ITU processes as they relate to aeronautical radio system frequency use is contained in the Handbook on Radio Frequency Spectrum Requirements for Civil Aviation including Statement of Approved ICAO Policies *(Doc 9718).*

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CHAPTER 3. SPECIFICATIONS FOR RADIO NAVIGATION AIDS

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3.1.7 VHF marker beacons

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3.1.7.2.1 The marker beacons shall operate at 75 MHz with a frequency tolerance of plus or minus ~~0.01~~ 0.005 per cent and shall utilize horizontal polarization. ~~As from 1 January 1985 all newly installed marker beacons shall have a frequency tolerance of plus or minus 0.005 per cent. After 1 January 1990 this provision applies for all marker beacons.~~

~~3.1.7.2.2 **Recommendation.**— *Marker beacons should operate with a frequency tolerance of plus or minus 0.005 per cent.*~~

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3.4 Specification for non-directional radio beacon (NDB)

. . .

3.4.6.6 The bandwidth of emissions and the level of spurious emissions shall be kept at the lowest value which the state of technique and the nature of the service permit.

Note.— Article ~~5~~ 5.3 of the Radio Regulations contains the general provisions with respect to technical characteristics of equipment and emissions. ~~Tolerances with respect to spurious emissions are specified in Appendix 8 to the Radio Regulations and guidance material for the determination of the necessary bandwidth is contained in Appendix 6.~~ The ITU Radio Regulations contain specific provisions relating to permitted bandwidth, frequency tolerance, and spurious emissions (see Appendices S1, S2, and S3).

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3.6 Specification for en-route VHF marker beacons (75 MHz)

3.6.1 Equipment

3.6.1.1 *Frequencies*. The emissions of an en-route VHF marker beacon shall have a radio frequency of 75 MHz plus or minus 0.02~~05~~ per cent. ~~As from 1 January 1985 all new installed en-route VHF marker beacons shall have a frequency tolerance of plus or minus 0.005 per cent. After 1 January 1990 this provision applies for all en-route VHF marker beacons.~~

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ATTACHMENT C. INFORMATION AND MATERIAL FOR GUIDANCE IN THE APPLICATION OF THE STANDARDS AND RECOMMENDED PRACTICES FOR ILS, VOR, PAR, 75 MHz MARKER BEACONS (EN-ROUTE), NDB AND DME

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3.1.2 Nominal values of the necessary ERP to achieve a field strength of 90 microvolts per metre (minus 107 dBW/m^2) are given at Figure C-13. For coverage under difficult terrain and siting conditions, it may be necessary to make appropriate increases in the effective radiated power. Conversely, practical experience has shown that under favourable siting conditions, and under the less pessimistic conditions often found in actual service, satisfactory system operation is achieved with a lower ERP.

Note.— The nominal effective radiated powers, expressed as a function of level and range, are based upon consideration of basic theoretical data from various sources (such as ~~CCIR~~ITU-R, NBS, etc.) modified empirically to reflect typical operational experience.

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6.3.2 *Assumptions*

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3. The level of atmospheric noise (RMS) which is likely to prevail: 1) by day, 2) by night, over land masses, within the belts of latitude mentioned. [The values of expected noise have been derived from Recommendation ITU-R P.372-~~6 Report No. 65 of the VIIIth Plenary Assembly of the CCIR (Warsaw, 1956), and the IXth Plenary Assembly of the CCIR (Los Angeles, 1959)~~ and have been taken as the average noise by day and by night during equinox periods, i.e. the values which are likely to be exceeded 20-25 per cent of the year.]

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VOLUME II
(COMMUNICATION PROCEDURES
including those with PANS status)

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CHAPTER 1. DEFINITIONS

When the following terms are used in this publication, they have the meaning prescribed in this chapter:

Note 1.— A list of additional specialized communication terms and their definitions is contained in Attachment A.

Note 2.— The designation (RR) in these definitions indicates a definition which has been extracted from the Radio Regulations of the ITU (see ICAO Handbook Doc 9718-AN/957).

1.1 Services

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Aeronautical mobile service (RR S1.32). A mobile service between aeronautical stations and aircraft stations, or between aircraft stations, in which survival craft stations may participate; emergency position-indicating radiobeacon stations may also participate in this service on designated distress and emergency frequencies.

Aeronautical mobile (R)* service (RR S1.33). An aeronautical mobile service reserved for communications relating to safety and regularity of flight, primarily along national or international civil air routes.

Aeronautical mobile-satellite service (RR S1.35). A mobile-satellite service in which mobile earth stations are located on board aircraft; survival craft stations and emergency position-indicating radiobeacon stations may also participate in this service.

Aeronautical mobile-satellite (R)* service (RR S1.36). An aeronautical mobile-satellite service reserved for communications relating to safety and regularity of flights, primarily along national or international civil air routes.

Aeronautical radio navigation service (RR S1.46). A radio navigation service intended for the benefit and for the safe operation of aircraft.

Note.— The following Radio Regulations are quoted for purposes of reference and/or clarity in understanding of the above definition of the aeronautical radio navigation service:

RR~~1~~ S1.10 Radio navigation: *Radiodetermination used for the purpose of navigation, including obstruction warning.*

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* route

RR~~1~~0S1.9 Radiodetermination: *The determination of the position, velocity and/or other characteristics of an object, or the obtaining of information relating to these parameters, by means of the propagation properties of radio waves.*

...

1.2 Stations

...

Aeronautical station (RR S1.81). A land station in the aeronautical mobile service. In certain instances, an aeronautical station may be located, for example, on board ship or on a platform at sea.

...

Aircraft station (RR S1.83). A mobile station in the aeronautical mobile service, other than a survival craft station, located on board an aircraft.

...

Radio direction finding (RR S1.12). Radiodetermination using the reception of radio waves for the purpose of determining the direction of a station or object.

Radio direction-finding station (RR S1.91). A radiodetermination station using radio direction finding.

...

1.3 Communication methods

...

Telecommunication (RR S1.3). Any transmission, emission, or reception of signs, signals, writing, images and sounds or intelligence of any nature by wire, radio, optical or other electromagnetic systems.

...

1.8 Miscellaneous

. . .

Frequency channel. A continuous portion of the frequency spectrum appropriate for a transmission utilizing a specified class of emission.

Note.— The classification of emissions and information relevant to the portion of the frequency spectrum appropriate for a given type of transmission (bandwidths) is specified in the ITU Radio Regulations, Article ~~4~~ S2 and Appendix S1; ~~RR 264 to RR 273 inclusive~~.

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CHAPTER 5. AERONAUTICAL MOBILE SERVICE

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5.1.8.2 *Urgency messages and urgency traffic,* including messages preceded by the medical transports signal, shall be handled in accordance with the provisions of 5.3.

Note.— The term "medical transports" is defined in the 1949 Geneva Conventions and Additional Protocols (see also RR S33 Section III) and refers to 'any means of transportation by land, water, or air, whether military or civilian, permanent or temporary, assigned exclusively to medical transportation and under the control of a competent authority of a Party to the conflict'.

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5.2 Radiotelephony procedures

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Note 1.— The pronunciation of the words in the alphabet as well as numbers may vary according to the language habits of the speakers. In order to eliminate wide variations in pronunciation, ~~a poster (No. P674)~~ posters illustrating the ~~desired~~ pronunciation ~~is~~ desired are available from ICAO.

Note 2.— The Spelling Alphabet specified in 5.2.1.2 is also prescribed for use in the Maritime Mobile Service (ITU Radio Regulations, Appendix ~~24~~ S14).

Figure 5-1. The Radiotelephony Spelling Alphabet (*see* 5.2.1.2)

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5.2.1.6 *Calling*

5.2.1.6.1 *Radiotelephony call signs for aeronautical stations*

Note.— The formation of call signs as specified in ITU Radio Regulations S19 Section III and Section VII.

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5.2.1.6.2.1 *Full call signs*

5.2.1.6.2.1.1 An aircraft radiotelephony call sign shall be one of the following types:

. . .

~~*Note 2.— The call signs referred to in a), b) and c) above comprise combinations in accordance with the ITU Radio Regulations (No. 2129 and No. 2130).*~~

Note ~~3~~2.— The telephony designators referred to in b) and c) above are contained in ICAO Doc 8585 — Designators for Aircraft Operating Agencies, Aeronautical Authorities and Services.

Note ~~4~~3.— Any of the foregoing call signs may be inserted in field 7 of the ICAO flight plan as the aircraft identification. Instructions on the completion of the flight plan form are contained in PANS-RAC, Doc 4444.

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5.3 Distress and urgency radiotelephony communication procedures

5.3.1 General

Note.— The distress and urgency procedures contained in 5.3 relate to the use of radiotelephony. The provisions of Article ~~39~~S30 and Appendix S13 of the ITU Radio Regulations are generally applicable, except that S30.9 permits other procedures to be employed where special arrangements between governments exist, ~~in the event that radiotelegraphy may still be employed in the aeronautical mobile service,~~ and are also applicable to radiotelephony communications between aircraft stations and stations in the maritime mobile service.

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CHAPTER 6. AERONAUTICAL RADIO NAVIGATION SERVICE

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6.2.12 According to the estimate by the direction-finding station of the accuracy of the observations, bearings and positions shall be classified as follows:

. . .

~~*Note.— The observational characteristics for classification of bearings are given in the table of Appendix 41 to the current ITU Radio Regulations.*~~

Editorial Note.— RRs no longer have a Table of Classification for bearings.

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VOLUME III
(COMMUNICATION SYSTEMS)

PART I — DIGITAL DATA COMMUNICATION SYSTEMS

CHAPTER 1. DEFINITIONS

Note 1.— All references to "Radio Regulations" are to the Radio Regulations published by the International Telecommunication Union. Radio Regulations are amended from time to time by the decisions embodied in the Final Acts of World Radio Conferences held nominally each two years. Further information on the ITU processes as they relate to aeronautical radio system frequency use is contained in the Handbook on Radio Frequency Spectrum Requirements for Civil Aviation including Statement of Approved ICAO Policies *(Doc 9718).*

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CHAPTER 4. AERONAUTICAL MOBILE-SATELLITE SERVICE

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4.2.1.1 USE OF AMS(R)S BANDS

Note.— Categories of messages, and their relative priorities within the aeronautical mobile (R) service, are given in Annex 10, Volume II, 5.1.8. These categories and priorities are equally valid for the aeronautical mobile ~~(R)~~ satellite (R) service (see ITU Radio Regulation ~~No. 3651~~ Article S44).

4.2.1.1.1 Every aircraft earth station and ground earth station shall be designed to ensure that messages defined in Annex 10, Volume II, 5.1.8 are not delayed by the transmission and/or reception of other types of messages employing frequencies within the bands stated in 4.2.1.2 and 4.2.1.3 or other frequencies to which the station can tune. Message types not defined in Annex 10, Volume II, 5.1.8 shall be terminated if necessary, and without warning, to allow Annex 10, Volume II, 5.1.8 type messages to be transmitted and received.

Note.— See ITU Radio Regulations, Article ~~8~~ S5, No. ~~729A~~ S5.357A.

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4.2.1.2.3 **Recommendation.**— *The aircraft earth station should also be capable of receiving in the frequency band 1 525 to 1 544 MHz.*

Note.— The band 1 525 to 1 544 MHz may be used to communicate for purposes of distress and public correspondence with stations of the maritime mobile-satellite service in accordance with ~~No. 3571 of the~~ ITU Radio Regulations Article S41.

. . .

4.2.1.3.3 **Recommendation.**— *The aircraft earth station should also be capable of transmitting in the frequency band 1 626.5 to 1 645.5 MHz.*

Note.— The band 1 626.5 to 1 645.5 MHz may be used to communicate for purposes of distress and public correspondence with stations of the maritime mobile-satellite service in accordance with ~~No. 3571 of the~~ ITU Radio Regulations Article S41.

. . .

4.2.3.1.2 *Polarization.* The polarization shall be right-hand circular for both receiving and transmitting, in accordance with the definition of ~~CCIR Recommendation 573~~ ITU Radio Regulations No. S1.154.

. . .

4.3.3 *Demodulator performance.* Where the channel rates are implemented as defined in 4.1, the bit error rate (BER) performance of the channel demodulators after descrambling shall be equal to or better than that shown in Table 4-8. This performance shall be attained under the following conditions:

a) in the presence of two adjacent interfering carriers on either side of the wanted carrier at a level of 5 dB higher than the wanted carrier with a frequency uncertainty from the nominal carrier spacing as specified and for the AES demodulator, with the AES operating up to its maximum allowable operating EIRP;

b) while receiving a signal transmitted with the maximum phase noise characteristics described in 4.2.3.5.9;

c) during 12° RF phase discontinuities occurring at the rate of one per second; and

d) under Rician channel conditions for fading bandwidths of 20, 60 and 100 Hz with a carrier to multipath ratio of 7 dB for systems using a low gain antenna or low and high gain antennas; or 10 dB for systems using only a high gain antenna.

Note.— Bit error performance objectives for AMS(R)S radio link are contained in ITU-R Recommendation M.1037.

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4.4.2.2.5.1 *Scrambling.* A scrambler with a 15-stage generator register shall be used for data scrambling before FEC coding. The polynomial for the generator register of the scrambler and the descrambler shall be $1 + X + X^{15}$. The scrambler and descrambler shall be clocked at the information rate with the first scrambled bit output before the first shift. In the absence of programming commands, the shift register shall be initialized to 1101 0010 1011 001 (leftmost bit in shift register stage 1) at the beginning of the information field of each frame. The scrambler and descrambler functions shall be as illustrated in Figure 4-3. The scrambler shall be re-initialized at the beginning of the information field of each frame.

Note.— The concept of a scrambler is explained in ~~CCIR Report 384-3~~ITU-R Recommendation S.446-4, Annex ~~H~~, Section 4.3.1~~;~~ Method 1.

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CHAPTER 6. VHF AIR-GROUND DIGITAL LINK (VDL)

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6.1.4.1.1 The radio frequencies used shall be selected from the radio frequencies in the band 117.975 – 137 MHz in accordance with the conditions of ITU Radio Regulations ~~595~~. The lowest assignable frequency shall be 118.000 MHz and the highest assignable frequency shall be 136.975 MHz. The separation between assignable frequencies (channel spacing) shall be 25 kHz.

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6.2.3.1 Spurious emissions shall be kept at the lowest value which the state of the technique and the nature of the service permit.

Note.— Appendix ~~8~~ S3 to the Radio Regulations specifies ~~contains the tolerances for~~ the levels of spurious emissions to which transmitters must conform ~~in accordance with Radio Regulation 304~~.

. . .

6.3.3.1 Spurious emissions shall be kept at the lowest value which the state of the technique and the nature of service permit.

Note.— Appendix ~~8~~ S3 to the Radio Regulations specifies ~~contains the tolerances for~~ the levels of spurious emission to which transmitters must conform ~~in accordance with Radio Regulation 304~~.

. . .

6.4.3.1.6 *Bit scrambling.* To aid clock recovery and to stabilize the shape of the transmitted spectrum, bit scrambling shall be applied. The pseudo noise (PN) sequence shall be a 15-stage generator (see Figure 6-1[2]) with the characteristic polynomial:

$$X^{15} + X + 1$$

The PN-sequence shall start after the frame synchronization pattern with the initial value 1101 0010 1011 001 with the left-most bit in the first stage of the register as per Figure 6-1. After processing each bit, the register shall be shifted one bit to the right. For possible encryption in the future this initial value shall be programmed. The sequence shall be added (modulo 2) to the data at the transmit side (scrambling) and to the scrambled data at the receive side (descrambling) per Table 6-4.

Note.— The concept of a PN scrambler is explained in ~~the International Radio Consultative Committee (CCIR) Report 384-3~~ITU-R Recommendation S.446-4, Annex ~~III~~, Section ~~3~~ 4.3.1, Method 1 (see Appendix A).

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Appendix to Chapter 6

REFERENCES

. . .

3. BACKGROUND REFERENCES

The following documents are listed as reference material.

Originator	*Title*	*Date published*
~~CCIR~~	~~*Report 384-3, Annex III*~~	
ITU-R	Recommendation S.446.4, Annex I	
CCSDS	*Telemetry Channel Coding, Recommendation for Space Data System Standards,* Consultative Committee for Space Date System, CCSDS 101.0-B-3, Blue Book	5/92

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Attachment A to Part I

GUIDANCE MATERIAL FOR AERONAUTICAL MOBILE-SATELLITE SERVICE

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2.1.1 *Message categories*. The transmission sequence at any aircraft earth station (AES) or ground earth station (GES) will be ordered in accordance with a given priority scheme. At the subnetwork interface to the AMSS, the priority scheme for packet data is as described in Annex 10, Volume III, Part I, Chapter 4, Table 4-26. Within the AMSS, this external priority scheme is augmented with internal priorities assigned to various signalling and voice-related functions. At the link layer this augmented priority scheme is referred to as the Q-precedence number and the resulting internal priority scheme is given in Table A-3 of this guidance material. This "Q-precedence" number list conforms to Annex 10 priorities, which in turn are derived from Article ~~51~~ S44 of the ITU Radio Regulations. The single Q-precedence list includes both voice and data traffic, and also includes the signalling necessary to integrate voice and data. The Q-precedence numbers associated with the signalling were chosen to optimize the over-all system performance and integrity.

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2.5.5 *Frequency management*. Careful frequency management is needed because:

a) AMSS includes safety services;

b) there is concern about the availability of adequate AMSS spectrum, and adequate capacity for AMSS safety services; and

c) the difficulty in co-ordinating mobile satellite networks due to the poor discrimination characteristics of mobile station antennas.

Guidelines that should be considered when co-ordinating frequency plans to minimize intra and interservice interference include:

a) compliance with the relevant ITU Radio Regulations;

b) each provider should provide monitoring facilities to identify the actual usage of AMS(R)S and non-AMS(R)S communications;

c) in those AMSS systems with global and spot beams, operational measures to minimize the amount of global bandwidth used and to maximize the use of spot beams;

d) using the ~~International Radio Consultative Committee (CCIR) three-phase~~ ITU-R Recommendations M.1089 and M.1233 technical co-ordination method, wherever possible ~~(see CCIR Report 1185)~~;

...

2.6.2 *Intersystem interference*. Intersystem interference refers to interference to an AMS(R)S service from any other system, whether it is providing AMS(R)S services or otherwise. Required performance should be maintained at whatever level of interference is adopted as operable through co-ordination among the particular satellite system operators. As a minimum, the AMSS satellite system should provide adequate performance in the presence of single-entry interference resulting in a $\Delta T/T$ of 6 per cent, as adopted by WARC-ORB-88 as the threshold requiring co-ordination between satellite systems. A suggested criterion for aggregate interference due to all sources, including intrasystem interference, is a $\Delta T/T$ of 20 per cent.

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VOLUME III
(COMMUNICATION SYSTEMS)

PART II — VOICE COMMUNICATION SYSTEMS

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CHAPTER 2. AERONAUTICAL MOBILE SERVICE

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2.1 AIR-GROUND VHF COMMUNICATION SYSTEM CHARACTERISTICS

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2.1.1.2 Spurious emissions shall be kept at the lowest value which the state of technique and the nature of the service permit.

Note.— Appendix ~~8~~ S3 to the ITU Radio Regulations specifies ~~contains the tolerances for~~ the levels of spurious emissions to which transmitters must conform ~~in accordance with RR 304~~.

2.1.1.3 The radio frequencies used shall be selected from the radio frequencies in the band 117.975 – 136 MHz and the band 136 – 137 MHz subject to the conditions of Radio Regulation 595. The separation between assignable frequencies (channel spacing) and frequency tolerances applicable to elements of the system shall be as specified in Volume V.

Note.— The band 117.975 – 132 MHz was allocated to the Aeronautical Mobile (R) Service in the ITU Radio Regulations (1947). By subsequent revisions ~~to the Regulations~~ at ITU World Administrative Radio Conferences the bands 132 – 136 MHz and 136 – 137 MHz were added ~~to the (R) allocation~~ under conditions which differ for ITU Regions, or for specified countries or combinations of countries (see RRs S5.203, S5.203A, and S5.203B for additional allocations in the band 136 – 137 MHz, and S5.201 for the band 132 – 136 MHz).

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2.4 SINGLE SIDEBAND (SSB) HF COMMUNICATION SYSTEM CHARACTERISTICS FOR USE IN THE AERONAUTICAL MOBILE SERVICE

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2.4.1.1 FREQUENCY RANGE

2.4.1.1.1 HF SSB installations shall be capable of operation at any SSB carrier (reference) frequency available to the Aeronautical Mobile (R) Service in the band 2.8 MHz to 22 MHz and necessary to meet the approved assignment plan for the region(s) in which the system is intended to operate, and in compliance with the relevant provisions of the Radio Regulations.

Note 1.— See Introduction to Volume V, Chapter 3 and Figures 2-1 and 2-2.

Note 2.— ~~The Extraordinary Administrative Radio Conference (EARC), Geneva, 1966, established an Allotment Plan (Appendix 27 to the Radio Regulations).~~ The ITU World Administrative Radio Conference, Aeronautical Mobile (R) Service, Geneva, 1978, established a new Allotment Plan (Appendix 27, ~~Aer2~~ to the Radio Regulations~~)~~ based on single sideband replacing the earlier double sideband Allotment Plan. The World Radiocommunication Conference 1995 redesignated it as Appendix S.27. Minor editorial changes were made at the World Radiocommunication Conference 1997.

. . .

~~2.4.1.3.1 Until 1 February 1983 channel utilization shall be in conformity with the Allotment Plan in either Appendix 27 EARC* or Appendix 27 Aer2** as follows:~~

~~a) where Appendix 27 EARC channels are used the carrier (reference) frequency shall in the case of the upper half of the previous DSB channel be the same as the carrier (reference) frequency of that channel;~~

~~b) where Appendix 27 EARC channels are used the carrier (reference) frequency shall in the case of the lower half of the previous DSB channel be 3 kHz lower than the carrier (reference) frequency of that channel;~~

~~c) where Appendix 27 Aer2 channels are used the carrier (reference) frequency shall be in conformity with the table at 27/16 of Appendix 27 Aer2.~~

2.4.1.3.2 ~~With effect from 1 February 1983~~ cChannel utilization shall be in conformity with the table of carrier (reference) frequencies at 27/16 and the Allotment Plan at 27/186 to 27/207 inclusive (or frequencies established on the basis of 27/21, as may be appropriate) of Appendix 27 ~~Aer2~~ S27.

. . .

2.4.1.8.1 *Aeronautical station installations.* Except as permitted by the relevant provisions of Appendix ~~27 Aer2~~ S27 to the ITU Radio Regulations the peak envelope power (P_p) supplied to the antenna transmission line for H2B, H3E, J3E, J7B or J9B classes of emissions shall not exceed a maximum value of 6 kW.

2.4.1.8.2 *Aircraft station installations.* The peak envelope power supplied to the antenna transmission line for H2B, H3E, J3E, J7B or J9B classes of emission shall not exceed 400 W except as provided for in Appendix ~~27 Aer2~~ S27 of the ITU Radio Regulations as follows:

S27/~~62~~ 68 It is recognized that the power employed by aircraft transmitters may, in practice, exceed the limits specified in No. 27~~54~~ 60. However, the use of such increased power (which normally should not exceed 600 W P_p shall not cause harmful interference to stations using frequencies in accordance with the technical principles on which the Allotment Plan is based.

S27/~~54~~ 60 Unless otherwise specified in Part II of this Appendix, the peak envelope powers supplied to the antenna transmission line shall not exceed the maximum values indicated in the table below; the corresponding peak effective radiated powers being assumed to be equal to two-thirds of these values:

Class of emission	*Stations*	*Max. peak envelope power (P_p)*
H2B, J3E, J7B, J9B, A3E*, H3E* (100% modulation)	Aeronautical stations Aircraft stations	6 kW 400 W
Other emission such as A1A, F1B	Aeronautical stations Aircraft stations	1.5 kW 100 W

* A3E and H3E to be used only on 3 023 kHz and 5 680 kHz~~, as well as in cases covered by Resolution No. 402~~.

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CHAPTER 5. EMERGENCY LOCATOR TRANSMITTER (ELT) FOR SEARCH AND RESCUE

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5.2 SPECIFICATION FOR THE 121.5 MHZ COMPONENT OF EMERGENCY LOCATOR TRANSMITTER (ELT) FOR SEARCH AND RESCUE

Note 1.— Information on technical characteristics and operational performance of 121.5 MHz ELTs is contained in RTCA Document DO-183 and European Organization for Civil Aviation Equipment (EUROCAE) Document ED.62.

Note 2.— Technical characteristics of emergency locator transmitters operating on 121.5 MHz are contained in ITU-R Recommendation M.690-1. The ITU designation for an ELT is Emergency Position — Indicating Radio Beacon (EPIRB).

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5.3.1 Technical characteristics

Note 1.— Transmission characteristics for emergency locator transmitters operating on 406 MHz are contained in ITU-R Recommendation M.633-1.

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APPENDIX 1 TO CHAPTER 5. EMERGENCY LOCATOR TRANSMITTER CODING

(see Chapter 5, 5.3.2)

Note.— A detailed description of beacon coding is contained in ITU-R Recommendation M.633-1 690-1. The following information is specific to emergency locator transmitters used in aviation.

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2.2 For ELTs with no navigation data provided, the short message format described in ITU-R Recommendation M.633-1 shall be used, making use of bits 1 through 112.

. . .

2.3.4 A country code, which indicates the State where additional data are available on the aircraft on which the ELT is carried, shall be contained in bits 27 through 36 which designate a three-digit decimal country code number expressed in binary notation.

~~*Note.— Country codes are based on the International Telecommunication Union (ITU) country code shown in Table 1 of Appendix 43 of the ITU Radio Regulations.*~~

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VOLUME IV
(SURVEILLANCE RADAR AND COLLISION AVOIDANCE SYSTEMS)

CHAPTER 1. DEFINITIONS

Note 1.— All references to "Radio Regulations" are to the Radio Regulations published by the International Telecommunication Union (ITU). Radio Regulations are amended from time to time by the decisions embodied in the Final Acts of World Radio Conferences held nominally each two years. Further information on the ITU processes as they relate to aeronautical radio system frequency use is contained in the Handbook on Radio Frequency Spectrum Requirements for Civil Aviation including Statement of Approved ICAO Policies *(Doc 9718).*

Note 2.— The Mode S extended squitter system is subject to patent rights from the Massachusetts Institute of Technology (MIT) Lincoln Laboratory. On 22 August 1996, MIT Lincoln Laboratory issued a notice in the Commerce Business Daily *(CBD), a United States Government publication, of its intent not to assert its rights as patent owner against any and all persons in the commercial or non-commercial practice of the patent, in order to promote the widest possible use of the Mode S extended squitter technology. Further, by letter to ICAO dated 27 August 1998, MIT Lincoln Laboratory confirmed that the CBD notice has been provided to satisfy ICAO requirements for a statement of patent rights for techniques that are included in SARPs, and that the patent holders offer this technique free of charge for any use.*

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VOLUME V
(AERONAUTICAL RADIO FREQUENCY SPECTRUM UTILIZATION)

. . .

CHAPTER 1. DEFINITIONS

Note.— All references to "Radio Regulations" are to the Radio Regulations published by the International Telecommunication Union. Radio Regulations are amended from time to time by the decisions embodied in the Final Acts of World Radio Conferences held nominally each two years. Further information on the ITU processes as they relate to aeronautical radio system frequency use is contained in the Handbook on Radio Frequency Spectrum Requirements for Civil Aviation including Statement of Approved ICAO Policies *(Doc 9718).*

. . .

Frequency channel. A continuous portion of the frequency spectrum appropriate for a transmission utilizing a specified class of emission.

Note.— The classification of emissions and information relevant to the portion of the frequency spectrum appropriate for a given type of transmission (bandwidths) are specified in the Radio Regulations, Article ~~4~~S2 and Appendix S1~~RR 264 to RR 273 inclusive~~.

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CHAPTER 2. DISTRESS FREQUENCIES

Introduction

Note.— ITU Radio Regulations Article S30 provides general conditions for distress and safety communications for all mobile services. Appendix S13 designates the frequencies to be used for these situations. The aeronautical mobile services is also permitted under Appendix S13, Part A1, §1 to conform to special arrangements between governments where these have been agreed. ICAO Annexes constitute such agreements.

. . .

The frequency 2 182 kHz also offers possibilities for communication between aircraft and stations of the Maritime Mobile Service. The ~~current~~ ITU Radio Regulations specify ~~(RR 2973)~~ Appendix S13, Part A2 that the frequency 2 182 kHz is the international distress frequency for radiotelephony to be used for that purpose by ship, aircraft and survival craft stations using frequencies in the authorized bands between 1 605 kHz and 4 000 kHz when requesting assistance from the maritime service.

With respect to emergency locator transmitters (ELTs) designed to be detected and located by satellite, the Radio Regulations authorize the use of these devices, which are referenced in ITU as satellite emergency position indicating radio beacons (EPIRBs). Radio Regulation ~~649~~ Appendix S13, Part A2

specifies that the band 406 – 406.1 MHz is used exclusively by satellite emergency position indicating radio beacons in the earth-to-space direction.

The frequency 4 125 kHz is also authorized by the ITU to enable communications between stations in the maritime mobile service and aircraft stations in distress. The current ITU Radio Regulations (RR ~~2982A/N2981~~ S5.130 and Appendix S13) state that the carrier frequency 4 125 kHz may be used by aircraft stations to communicate with stations of the maritime mobile service for distress and safety purposes. The aeronautical mobile (R) frequencies 3 023 kHz and 5 680 kHz may be employed for coordinated search and rescue operations with the maritime mobile service under RR S5.115.

Similarly, the frequency 500 kHz (RR S5.83) is the international distress frequency for Morse radiotelegraphy to be used for that purpose by ship, aircraft and survival craft stations using frequencies in the bands between 4~~0~~15 kHz and 535 kHz when requesting assistance from the maritime service (RR ~~2970~~ Appendix S13, Part A2).

With respect to survival craft stations, the Radio Regulations provide for the use of the frequency(ies) 500 kHz, 8 364 kHz, 2 182 kHz, 121.5 MHz and 243 MHz, if the survival craft is capable of operating in the bands between 4~~0~~15 – 535 kHz, 4 000 – 27 500 kHz, 1605 – 2 850 kHz, 117.975 – 13~~6~~7 MHz and 235 – 328.6 MHz respectively (~~RR 3001 to 3008~~RR Appendix S13 Part A2).

2.1 Frequencies for emergency locator transmitters (ELT) for search and rescue

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Note 1.— ITU Radio Regulations (~~No. 592~~S5.256 and Appendix S13) provide for the use of 243 MHz in addition to the above frequencies.

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CHAPTER 3. UTILIZATION OF FREQUENCIES BELOW 30 MHz

Introduction

High frequency bands allocated to the Aeronautical Mobile (R) Service

The frequency bands between 2.8 MHz and 22 MHz allocated to the Aeronautical Mobile (R) Service are given in Article ~~8~~ S5 of the ITU Radio Regulations. The utilization of these bands must be in accordance with the relevant provisions of the Radio Regulations. Prior to 1 September 1979, the provisions are contained in the Final Acts of the ITU Extraordinary Administrative Radio Conference (Geneva 1966). On 1 September 1979, revised provisions came into force, details of which are contained in the Final Acts of the World Administrative Radio Conference for the Aeronautical Mobile (R) Service (Geneva 1978) and Appendix 27 Aer2 to the Radio Regulations, except the Frequency Allotment Plan which entered into force at 0001 hours UTC, 1 February 1983. In the Radio Regulations, 1998 version, based on the World Administrative Radio Conference for the Mobile Services (1987), Appendix S27 now incorporates editorial amendments to the

Appendix 27 Aer2. In the utilization of these bands, States' attention is drawn to the possibility of harmful radio interference from non-aeronautical sources of radio frequency energy and the need to take appropriate measures to minimize its effects.

. . .

3.1.2.2 ~~Until 1 February 1983 it shall be permissible to use channels in the new Plan provided that no harmful interference occurs to users of channels in the present Plan.~~ For the operational use of the channels concerned administrations shall take into account the provisions of ~~27/20~~S27/19 of Appendix S27 ~~Aer2~~ of the ITU Radio Regulations.

3.1.2.3 **Recommendation.**— *The use of aeronautical mobile (R) frequencies below 30 MHz for international operations should be co-ordinated as specified in Appendix S27 ~~Aer2~~ of the ITU Radio Regulations as follows:*

~~27/20~~S27/19 The International Civil Aviation Organization (ICAO) co-ordinates radiocommunications of the Aeronautical Mobile (R) Service with international aeronautical operations and this Organization should be consulted in all appropriate cases in the operational use of the frequencies in the Plan.

3.1.2.4 **Recommendation.**— *Where international operating requirements for HF communications cannot be satisfied by the ~~allotments in the table at Nos. 27/195 to 27/207 in Appendix 27 EARC, Frequency~~ Allotment Plan at Part 2 of Appendix S27 to the Radio Regulations an appropriate frequency ~~should~~ may be assigned as specified in Appendix 27 ~~Aer2~~ S27 ~~of the Radio Regulations as follows~~ by the application of the following provisions:*

~~27/21~~S27/20 It is recognized that not all the sharing possibilities have been exhausted in the Allotment Plan contained in this Appendix. Therefore, in order to satisfy particular operational requirements which are not otherwise met by this Allotment Plan, administrations may assign frequencies from the aeronautical mobile (R) bands in areas other than those to which they are allotted in this Plan. However, the use of the frequencies so assigned must not reduce the protection to the same frequencies in the areas where they are allotted by the Plan below that determined by the application of the procedure defined in Part I, Section II B of this Appendix.

Note.— Part I, Section II B of Appendix 27 ~~Aer2~~ S27 relates to Interference Range Contours, and application of the procedure results in a protection ratio of 15 dB.

~~27/22~~S27/21 When necessary to satisfy the needs of international air operations administrations may adapt the allotment procedure for the assignment of aeronautical mobile (R) frequencies, which assignments shall then be the subject of prior agreement between administrations affected.

~~27/23~~S27/22 The co-ordination described in No. 27/~~20~~S27/21 shall be effected where appropriate and desirable for the efficient utilization of the frequencies in question, and especially when the procedures of No. 27/~~22~~S27/19 are unsatisfactory.

3.1.2.5 The use of classes of emission J7B and J9B shall be subject to the following provisions of Appendix S27~~Acr2~~:

~~127/11~~S27/12 For radiotelephony~~e~~ emissions the audio frequencies will be limited to between 300 and 2 700 Hz and the occupied bandwidth of other authorized emissions will not exceed the upper limit of J3E emissions. In specifying these limits, however, no restriction in their extension is implied in so far as emissions other than J3E are concerned, provided that the limits of unwanted emissions are met (see Nos. ~~27/66B~~S27/73 and ~~27/66C~~S27/74).

~~27/11B~~S27/14 On account of the possibility of interference, a given channel should not be used in the same allotment area for radiotelephony and data transmissions.

~~27/12~~S27/15 The use of channels derived from the frequencies indicated in S27/~~16~~18 for the various classes of emissions other than J3E and H2B will be subject to special arrangements by the administrations concerned and affected in order to avoid harmful interference which may result from the simultaneous use of the same channel for several classes of emission.

...

3.1.3.1 World-wide frequencies for aeronautical operational control communications are required to enable aircraft operating agencies to meet the obligations prescribed in Annex 6, Part I. Assignment of these frequencies shall be in accordance with the following provisions of Appendix S27~~Acr2~~:

~~27/8A~~S27/9 A world-wide allotment area is one in which frequencies are allotted to provide long distance communications between an aeronautical station within that allotment area and aircraft operating anywhere in the world.**

~~27/8A.1 The type of communication referred to in 27/8A may be regulated by Administrations.~~

~~27/194A~~S27/217 The world-wide frequency allotments appearing in the tables at No. S27/~~189~~213 and Nos. S27/~~195~~218 to S27/~~207~~231, except for carrier (reference) frequencies 3 023 kHz and 5 680 kHz, are reserved for assignment by administrations to stations operating under authority granted by the administration concerned for the purpose of serving one or more aircraft operating agencies. Such assignments are to provide communications between an appropriate aeronautical station and an aircraft station anywhere in the world for exercising control over regularity of flight and for safety of aircraft. World-wide frequencies are not to be assigned by administrations for MWARA, RDARA and VOLMET purposes. Where the operational area of an aircraft lies wholly within a RDARA or sub-RDARA boundary, frequencies allotted to those RDARAs and sub-RDARAs shall be used.

** The type of communications referred to in S27/9 may be regulated by administrations.

Note 1.— Tables S27/~~189~~213 and S27/~~195~~218 to S27/~~207~~231 appearing in Appendix S27 ~~Aer2~~ to the ITU Radio Regulations refer to, respectively, the Frequency Allotment Plan, listing frequencies by areas, and the Frequency Allotment Plan, listing frequencies in numerical order.

. . .

CHAPTER 4. UTILIZATION OF FREQUENCIES ABOVE 30 MHz

4.1 Utilization in the band 117.975 – 137 MHz

Introduction

The band 118 – 132 MHz was allocated in 1947 by the Atlantic City ITU Radio Conference, and again in 1959 by the Geneva Conference, but with extension downwards to 117.975 MHz, for the exclusive use by the Aeronautical Mobile (R) Service. ~~This Chapter of Annex 10 deals with Standards and Recommended Practices relating to this band and includes matters pertaining to the selection of particular frequencies for various aeronautical purposes. These Standards are introduced by the following preface, which sets out the principles upon which the utilization of VHF on a world-wide basis with due regard to economy has been planned.~~

ITU Radio Conferences subsequent to 1947 also made provisions for the use of the band 132 – 136 MHz for the Aeronautical Mobile (R) Service under conditions which vary for the different ITU Regions, countries or combination of countries. The utilization of this band has been included in the Allotment Table in this Chapter; ~~however, it should be kept in mind that the use of frequencies of the band 132 – 136 MHz must take account of the conditions contained in the notes against this band in the ITU Allocation Table~~. The ITU Radio Conference (1979) made provisions for the use of the band 136 – 137 MHz by the Aeronautical Mobile (R) Service, subject to conditions of No. ~~595~~ S5.203, S5.203A, and S5.203B of the Radio Regulations. The use of frequencies in this 136 – 137 MHz part of the band must take account of the conditions contained in these notes. In the utilization of these bands, States' attention is drawn to the possibility of harmful radio interference from non-aeronautical sources of radio frequency energy and the need to take appropriate measures to minimize its effects.

This chapter deals with Standards and Recommended Practices (SARPs) relating to this band and includes matters pertaining to the selection of particular frequencies for various aeronautical purposes. These Standards are introduced by the following preface, which sets out the principles upon which the utilization of VHF on a world-wide basis with due regard to economy has been planned.

. . .

4.1.3.1 *Emergency channel*

. . .

Note 2.— The current Radio Regulations make provisions that the aeronautical emergency frequency 121.5 MHz may also be used by mobile stations of the Maritime Mobile Service, using A3E emission to communicate on this frequency for safety purposes with stations of the Aeronautical Mobile Service (RR ~~593, 2990 and 2991)~~ S5.200 and Appendix S13, Part A2).

. . .

4.4 Utilization in the band 5 030.4 – 5 150.0 MHz

Note 1.— Guidance material on the frequency protection planning of MLS facilities is contained in Attachment G to Volume I.

Note 2.— Guidance on determining coordination distances between MLS facilities and ground stations providing feeder links to non-geostationary mobile satellites is contained in ITU-R Recommendation S.1342.

. . .

ATTACHMENT A. CONSIDERATIONS AFFECTING THE DEPLOYMENT OF VHF COMMUNICATION FREQUENCIES

. . .

2.4 The following additional assumptions were made in establishing the criteria:

1) *Propagation*: free space propagation between aircraft. The ~~CCIR~~ ITU-R curves for 100 MHz vertical polarization over land in conjunction with an assumed ground antenna height of 20 m (65 ft) were used in computing ground-air field strengths.

. . .

ATTACHMENT C. GUIDING PRINCIPLES FOR LONG DISTANCE OPERATIONAL CONTROL COMMUNICATIONS

. . .

5. VHF (general purpose or AOC channels) and not HF should be used when an aircraft is within the coverage of an appropriate VHF aeronautical station.

Note.— The specific categories of messages that may be handled on Aeronautical Mobile (R) Service channels are prescribed in Annex 10, Volume II, Chapter 5, 5.1.8. The same Chapter defines the standard communications procedures for the Service including the requirements for maintaining watch in Annex 10, Volume II, Chapter 5, 5.2.2. In accordance with RR ~~2025~~ S18.6, ~~Article 24~~ of the ITU Radio Regulations, licences should define the purpose of the station for aeronautical ~~O~~operational ~~C~~control (as defined in Annex 6, Part I) and should specify the general characteristics in accordance with Appendix 27 of the Radio Regulations.

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ATTACHMENT B to State letter AN 7/1.3.81-00/70

PROPOSED AMENDMENT TO
ANNEX 10, VOLUME III, PART I, CHAPTER 6

(VDL MODES 1, 2, 3 AND 4)

NOTES ON THE PRESENTATION OF THE AMENDMENT TO ANNEX 10

The text of the amendment is arranged to show deleted text with a line through it and new text highlighted with grey shading, as shown below:

1. ~~Text to be deleted is shown with a line through it.~~	text to be deleted
2. New text to be inserted is highlighted with grey shading.	new text to be inserted
3. ~~Text to be deleted is shown with a line through it~~ followed by the replacement text which is highlighted with grey shading.	new text to replace existing text

INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

AERONAUTICAL TELECOMMUNICATIONS

ANNEX 10
TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

VOLUME III
(COMMUNICATION SYSTEMS)
(PART I — DIGITAL DATA COMMUNICATION SYSTEMS)

. . .

CHAPTER 6. VHF AIR-GROUND DIGITAL LINK (VDL)

6.1 DEFINITIONS AND SYSTEM CAPABILITIES

Note 1.— The very high frequency (VHF) digital link (VDL) Mode 2 and the VDL Mode 4 provide data service capabilities. The VDL Mode 3 provides both voice and data service capabilities. The data capability is a constituent mobile subnetwork of the aeronautical telecommunication network (ATN)~~, operating in the aeronautical mobile VHF frequency band~~. In addition, the VDL may provide non-ATN functions~~ such as, for instance, digitized voice~~. The~~ very high frequency (VHF) digital link (VDL)~~ Standards and Recommended Practices (SARPs) *for the VDL are defined and referenced below~~ apply to aeronautical VHF digital communications systems operating within the aeronautical telecommunication network (ATN)~~.*

Note 2.— Additional information on VDL is contained in the Manuals on VDL Mode 2, VDL Mode 3 and VDL Mode 4 Technical Specifications.

Note 3.— Sections 6.1.2 to 6.8.2 contain Standards and Recommended Practices for VDL Modes 2 and 3. Section 6.9 contains Standards and Recommended Practices for VDL Mode 4.

Note 4.— VDL Mode 4 SARPs apply to surveillance applications (e.g. ADS-B and ADS-C).

6.1.1 Definitions

Aeronautical telecommunications network. An internetwork architecture that allows ground, air-ground, and aircraft data subnetworks to interoperate by adopting common interface services and protocols based

on the International Organization for Standardization (ISO) Open Systems Interconnection (OSI) Reference Model.

~~***Aircraft address.*** A unique combination of 24 bits available for assignment to an aircraft for the purpose of air-ground communications, navigation and surveillance.~~

~~***Asynchronous balanced mode.*** A balanced operational mode in which a data link connection has been established between two service access points. Either data link entity can send commands at any time and initiate responses without receiving permission from the peer data link entity on the connection.~~

~~***Asynchronous disconnected mode.*** A balanced non-operational mode in which no logical data link connection exists between two link layer entities. A connection must be established before data can be sent.~~

~~***ATN router.*** An intermediate system used to interconnect subnetworks conforming to the lower three layers of the OSI reference model.~~

Automatic dependent surveillance-broadcast (ADS-B). A surveillance application transmitting parameters, such as position, track and ground speed, via a broadcast mode data link for use by any air and/or ground users requiring it.

Note.— ADS-B is a surveillance service based on aircraft self-determination of position/velocity/time and automatic, periodic or random, broadcast of this information along with auxiliary data such as aircraft identity (ID), communications control parameters, etc. ADS-B is intended to support multiple high-level applications and associated services such as cockpit display of traffic information, traffic alert and collision avoidance functionality, enhanced traffic management in the air and on the ground, search and rescue support and others.

~~***Autotune function.*** The function, performed by the link management entity, allows a ground station to command an aircraft to change frequencies.~~

Broadcast. A transmission intended to be received by all stations.

~~***Broadcast handoff.*** The process by which a ground LME commands certain aircraft to execute a link handoff and optionally maintain its current subnetwork connections, without the need to explicitly confirm the link handoff or optionally the subnetwork connection maintenance.~~

~~***Broadcast link handoff.*** The process by which a ground LME commands certain aircraft to execute a link handoff to a specific ground station without the need to explicitly confirm the link handoff.~~

~~***Broadcast subnetwork connection handoff.*** The process by which a ground LME commands certain aircraft to execute a link handoff to a specific ground station and maintain its current subnetwork connections without the need to explicitly confirm the link handoff or the subnetwork connection maintenance.~~

Burst. A time-defined, contiguous set of one or more related signal units which may convey user information and protocols, signalling, and any necessary preamble.

~~***Current link (or current ground station).*** Either the ground-to-aircraft link or the active link when in the process of a handoff.~~

Current slot. The slot in which a received transmission begins.

Data circuit-terminating equipment (DCE). A DCE is a network provider equipment used to facilitate communications between DTEs.

Data link entity (DLE). A protocol state machine capable of setting up and managing a single data link connection.

Data link service (DLS) sub-layer. The sub-layer that resides above the MAC sub-layer. For VDL Mode 4, the DLS sub-layer resides above the VSS sub-layer. The DLS manages the transmit queue, creates and destroys DLEs for connection-oriented communications, provides facilities for the LME to manage the DLS, and provides facilities for connectionless communications.

Data terminal equipment (DTE). A DTE is an endpoint of a subnetwork connection.

~~***Effective data rate.*** The actual instantaneous data throughput realized after overheads imposed by bit stuffing and by any forward error correction encoding, but not retransmissions.~~

~~***Expedited subnetwork connection establishment.*** The process by which an aircraft DTE establishes a subnetwork connection with a ground DTE with which it does not have a subnetwork connection during link establishment (or aircraft-initiated handoff) by inserting the CALL REQUEST packet and its response in the link establishment (or aircraft-initiated handoff) frame and its response.~~

~~***Expedited subnetwork connection maintenance.*** The process by which an aircraft or ground DTE maintains a subnetwork connection with a DTE with which it has a subnetwork connection during link handoff by inserting the CALL REQUEST packet and its response in the link handoff frame and its response.~~

~~***Explicit subnetwork connection establishment.*** The process by which an aircraft DTE establishes a subnetwork connection with a ground DTE with which it does not have a subnetwork connection only after completing the link establishment (or handoff).~~

~~***Explicit subnetwork connection maintenance.*** The process by which an aircraft DTE maintains a subnetwork connection with a ground DTE with which it has a subnetwork connection only after completing the link handoff.~~

Extended Golay Code. An error correction code capable of correcting multiple bit errors.

Frame. The link layer frame is composed of a sequence of address, control, FCS and information fields. For VDL Mode 2, these fields are bracketed by opening and closing flag sequences. ~~A valid frame is at least 11 octets in length and contains an address field (8 octets), a link control field (1 octet) and a frame check sequence (2 octets). A~~ and a frame may or may not include a variable-length information field.

Gaussian filtered frequency shift keying (GFSK). A continuous-phase, frequency shift keying technique using two tones and a Gaussian pulse shape filter.

Global signalling channel (GSC). A channel available on a world-wide basis which provides for communication control.

~~***Initiated handoff.*** The transmission process by which a station initiates link handoff.~~

~~***Internetworking protocol.*** A protocol that transfers data packets between intermediate systems and end systems interconnected by subnetworks and that is supported by the routing protocols and addressing plan.~~

Link. A link connects an aircraft DLE and a ground DLE and is uniquely specified by the combination of aircraft DLS address and the ground DLS address. A different subnetwork entity resides above every link endpoint.

~~***Link establishment.*** The process by which an aircraft and a ground LME discover each other, determine to communicate with each other, decide upon the communication parameters, create a link and initialize its state before beginning communications.~~

~~***Link handoff.*** The process by which peer LMEs, already in communication with each other, create a link between an aircraft and a new ground station before disconnecting the old link between the aircraft and the current ground station.~~

Link layer. The layer that lies immediately above the physical layer in the Open Systems Interconnection protocol model. The link layer provides for the reliable transfer of information across the physical media. It is subdivided into the data link sub-layer and the media access control sub-layer.

Link management entity (LME). A protocol state machine capable of acquiring, establishing, and maintaining a connection to a single peer system. An LME establishes data link and subnetwork connections, "hands-off" those connections, and manages the media access control sub-layer and physical layer. An aircraft LME tracks how well it can communicate with the ground stations of a single ground system. An aircraft VME instantiates an LME for each ground station that it monitors. Similarly, the ground VME instantiates an LME for each aircraft that it monitors. An LME is deleted when communication with the peer system is no longer viable.

M burst. A management channel data block of bits used in VDL Mode 3. This burst contains signalling information needed for media access and link status monitoring.

Media access control (MAC). The sub-layer that acquires the data path and controls the movement of bits over the data path.

Mode 2. A data-only VDL mode that uses D8PSK modulation and a carrier sense multiple access (CSMA) control scheme.

Mode 3. A voice and data VDL mode that uses D8PSK modulation and a TDMA media access control scheme.

Mode 4. A data link using a gaussian-filtered frequency shift keying modulation scheme and self-organizing time division multiple access.

~~***Multicast.*** A transmission intended to be received by multiple stations.~~

~~***Network layer.*** The layer that provides the upper layers with independence from the data transmission and routing functions used to connect systems. The network layer is responsible for routing and relaying functions both within any subnetwork and throughout the aeronautical internetworking domain.~~

~~***New link (or new ground station).*** After successful completion of handoff (or link establishment), the new "current" link.~~

~~***N(r).*** The receive sequence number at the link layer, which indicates the sequence number of the next expected frame (and explicitly acknowledges all lesser numbered frames).~~

~~***N(s).*** The send sequence number at the link layer, which indicates the sequence number associated with a transmitted frame.~~

~~***Old link (or old ground station).*** Following link establishment during a handoff, the link that was previously the "current" link becomes the "old" link.~~

Physical layer. The lowest level layer in the Open Systems Interconnection protocol model. The physical layer is concerned with the transmission of binary information over the physical medium (e.g. VHF radio).

~~***Private parameters.*** The parameters that are contained in exchange identity (XID) frames and that are unique to the VHF digital link environment.~~

~~***Proposed link (or proposed ground station).*** The link being negotiated (in a handoff) to replace the current link.~~

Quality of service. The information relating to data transfer characteristics used by various communication protocols to achieve various levels of performance for network users.

Reed-Solomon code. An error correction code capable of correcting symbol errors. Since symbol errors are collections of bits, these codes provide good burst error correction capabilities.

~~***Requested handoff.*** The one-transmission process by which a station requests its peer entity to initiate a link handoff.~~

~~***Service primitives.*** The status and control information that must be available to the receiving entity to properly process incoming information. A service primitive may contain parameters. If parameters exist,~~

~~they describe information that is defined either as mandatory (M) or optional (O) for conformance to a particular communications standard.~~

~~***Service provider.*** An entity at a layer that provides services to the layer above. These services are provided at service access points through the use of service primitives.~~

~~***Service user.*** An entity at a layer that makes use of the services that are provided at service access points by the layer below through the use of service primitives.~~

Self-organizing time division multiple access (STDMA). A multiple access scheme based on time-shared use of a radio frequency (RF) channel employing: (1) discrete contiguous time slots as the fundamental shared resource; and (2) a set of operating protocols that allows users to mediate access to these time slots without reliance on a master control station.

Slot. One of a series of consecutive time intervals of equal duration. Each burst transmission starts at the beginning of a slot.

Subnetwork connection. A long-term association between an aircraft DTE and a ground DTE using successive virtual calls to maintain context across link handoff.

~~***Subnetwork connection maintenance.*** The process by which the VDL SNDCF maintains subnetwork context from one subnetwork connection to the next during handoffs.~~

~~***Subnetwork connection management.*** The process by which the VDL SNDCF initially establishes a connection and then maintains it during handoffs.~~

Subnetwork dependent convergence ~~facility~~ function (SNDCF). A ~~facility~~ function that matches the characteristics and services of a particular subnetwork to those characteristics and services required by the internetwork facility.

Subnetwork entity. In this document, the phrase "ground DCE" will be used for the subnetwork entity in a ground station communicating with an aircraft; the phrase "ground DTE" will be used for the subnetwork entity in a ground router communicating with an aircraft station; and, the phrase "aircraft DTE" will be used for the subnetwork entity in an aircraft communicating with the station. A subnetwork entity is a packet layer entity as defined in ISO 8208.

Subnetwork layer. The layer that establishes, manages, and terminates connections across a subnetwork.

System. A VDL-capable entity. A system comprises one or more stations and the associated VDL management entity. A system may either be an aircraft system or a ground system.

~~***T.*** The baud period or 1/baud rate.~~

~~***Unicast.*** A transmission addressed to a single station.~~

Time division multiple access (TDMA). A multiple access scheme based on time-shared use of an RF channel employing: (1) discrete contiguous time slots as the fundamental shared resource; and (2) a set of operating protocols that allows users to interact with a master control station to mediate access to the channel.

User group. A group of ground and/or aircraft stations which share voice and/or data connectivity. For voice communications, all members of a user group can access all communications. For data, communications include point-to-point connectivity for air-to-ground messages, and point-to-point and broadcast connectivity for ground-to-air messages.

VDL management entity (VME). A VDL-specific entity that provides the quality of service requested by the ATN-defined SN_SME. A VME uses the LMEs (that it creates and destroys) to enquire the quality of service available from peer systems.

~~***VDL station.*** A VDL-capable entity. A VDL station may either be an aircraft station or a ground station. A VDL station is a physical entity that transmits and receives frames over the air-ground interface and comprises, at a minimum: a physical layer, media access control sub-layer, and a unique DLS address. The particular initiating process (i.e. DLE or LME) in the VDL station cannot be determined by the source DLS address. The particular destination process cannot be determined by the destination DLS address. These can only be determined by the context of these frames as well as the current operational state of the DLEs.~~

VDL Mode 4 burst. A VHF digital link (VDL) Mode 4 burst is composed of a sequence of source address, burst ID, information, slot reservation, and frame check sequence (FCS) fields, bracketed by opening and closing flag sequences.

Note.— The start of a burst may occur only at quantized time intervals and this constraint allows the propagation delay between the transmission and reception to be derived.

VDL Mode 4 DLS system. A VDL system that implements the VDL Mode 4 DLS and subnetwork protocols to carry ATN packets or other packets.

VDL Mode 4 specific services (VSS) sublayer. The sublayer that resides above the MAC sublayer and provides VDL Mode 4 specific access protocols including reserved, random and fixed protocols.

VDL Mode 4 station. A physical entity that transmits and receives VDL Mode 4 bursts over the RF interface and comprises, as a minimum: a physical layer, media access control sublayer and a VSS sublayer. A VDL Mode 4 station may either be a mobile VDL Mode 4 station or a ground VDL Mode 4 station.

Vocoder. A low bit rate voice encoder/decoder.

Voice unit. A device that provides a simplex audio and signalling interface between the user and VDL.

VSS user. A user of the VDL Mode 4 specific services. The VSS user could be higher layers in the VDL Mode 4 SARPs or an external application using VDL Mode 4.

6.1.2 Radio channels and functional channels

6.1.2.1 *Aircraft station radio frequency range*. An aircraft station shall be capable of tuning to any of the ~~760 25-kHz~~ channels ~~from 118.000 MHz through 136.975 Mhz~~ in the range specified in Section 6.1.4.1 within 100 milliseconds ~~of~~ after the receipt of ~~the~~ an autotune command. In addition, for VDL Mode 3, an aircraft station shall be able to tune to any channel in the range specified in Section 6.1.4.1 within 100 milliseconds after the receipt of any tuning command.

6.1.2.2 *Ground station radio frequency range*. A ground station shall be capable of operating on its assigned channel within the spectrum detailed in ~~6.1.2.1~~6.1.4.1.

6.1.2.3 *Common signalling channel*. Frequency 136.975 MHz shall be ~~used~~reserved as a world-wide common signalling channel (CSC) for VDL Mode 2 ~~to announce the availability of any VDL services~~.

6.1.3 System capabilities

~~The VDL communications functions shall meet the general requirements in 6.1.3.1 through 6.1.3.4 below.~~

6.1.3.1 *Data transparency*. The VDL system shall provide code-independent, byte-independent transfer of data.

6.1.3.2 *Broadcast*. The VDL system shall provide link layer data broadcast services (Mode 2) and/or voice and data broadcast services (Mode 3). For VDL Mode 3, the data broadcast service shall support network multicasting capability originating from the ground.

6.1.3.3 *Connection management*. The VDL system shall establish and maintain a reliable communications path between the aircraft and the ground system while allowing but not requiring manual intervention.

Note.— In this context "reliable" is defined by the BER requirement specified in 6.3.5.1.

6.1.3.4 *Ground network transition*. A VDL-equipped aircraft shall transition from one ground station to another when circumstances dictate.

6.1.3.5 *Voice capability*. The VDL Mode 3 system shall support a transparent, simplex voice operation based on a "Listen-Before-Push-To-Talk" channel access.

6.1.4 Air-ground VHF digital link communications system characteristics

~~6.1.4.1 The characteristics of the air-ground VHF digital link (VDL) communications system used in the international aeronautical mobile service shall be in conformity with the following specifications:~~

6.1.4.~~1~~.1 The radio frequencies used shall be selected from the radio frequencies in the band 117.975 - 137 MHz ~~in accordance with the conditions of Radio Regulation 595~~ . The lowest assignable frequency shall be 118.000 MHz and the highest assignable frequency shall be 136.975 MHz. The separation between assignable frequencies (channel spacing) shall be 25 kHz.

Note.— Volume V specifies that the block of frequencies from 136.9 - 136.975 MHz inclusive is reserved for VHF air-ground digital communications.

6.1.4.~~1~~.2 The design polarization of emissions shall be vertical.

6.2 SYSTEM CHARACTERISTICS OF THE GROUND INSTALLATION

6.2.1 Ground station transmitting function

6.2.1.1 *Frequency stability.* The radio frequency of VDL ground station equipment operation shall not vary more than plus or minus 0.0002 per cent (2 parts per million) from the assigned frequency.

Note.— The frequency stability for VDL ground stations using DSB-AM modulation is specified in Volume III, Part II, Chapter 2 for 25 kHz channel spacing.

6.2.2 Power

Recommendation.— *The effective radiated power should be such as to provide a field strength of at least 75 microvolts per metre (minus 109 dBW/m^2) within the defined operational coverage of the facility, on the basis of free-space propagation.*

6.2.3 Spurious emissions

6.2.3.1 Spurious emissions shall be kept at the lowest value which the state of the technique and the nature of the service permit.

Note.— Appendix ~~8~~ S3 to the Radio Regulations specifies ~~contains the tolerances for~~ the levels of spurious emissions to which transmitters must conform ~~in accordance with Radio Regulation 304~~.

6.2.4 Adjacent channel emissions

6.2.4.1 The amount of power from a VDL ground transmitter under all operating conditions when measured over the 25 kHz channel bandwidth of the first adjacent channel shall not exceed 0 dBm.

6.2.4.1.1 After 1 January 2002, the amount of power from all new installations of a VDL ground transmitter under all operating conditions when measured over the 25 kHz channel bandwidth of the first adjacent channel shall not exceed 2 dBm.

6.2.4.2 The amount of power from a VDL ground transmitter under all operating conditions when measured over the 25 kHz channel bandwidth of the second adjacent channel shall be less than minus 25 dBm and from thereon it shall monotonically decrease at the minimum rate of 5 dB per octave to a maximum value of minus 52 dBm.

6.2.4.2.1 After 1 January 2002, the amount of power from all new installations of a VDL ground transmitter under all operating conditions when measured over the 25 kHz channel bandwidth of the second adjacent channel shall be less than minus 28 dBm.

6.2.4.2.2 After 1 January 2002, the amount of power from all new installations of a VDL ground transmitter under all operating conditions when measured over the 25 kHz channel bandwidth of the fourth adjacent channel shall be less than minus 38 dBm, and from thereon it shall monotonically decrease at the minimum rate of 5 dB per octave to a maximum value of minus 53 dBm.

6.2.4.3 The amount of power from a VDL ground transmitter under all operating conditions when measured over a 16 kHz channel bandwidth centered on the first adjacent channel shall not exceed minus 20 dBm.

6.2.4.3.1 After 1 January 2002, the amount of power from all new installations of a VDL ground transmitter under all operating conditions when measured over a 16 kHz channel bandwidth centred on the first adjacent channel shall not exceed minus 18 dBm.

6.2.4.4 After 1 January 2005, all VDL ground transmitters shall meet the provisions of 6.2.4.1.1, 6.2.4.2.1, 6.2.4.2.2 and 6.2.4.3.1 above, subject to the conditions of 6.2.4.5 below.

6.2.4.5 Requirements of mandatory compliance of the provisions of 6.2.4.4 above shall be made on the basis of regional air navigation agreements which specify the airspace of operation and the implementation timescales. The agreements shall provide at least two years' notice of mandatory compliance of ground systems.

6.3 SYSTEM CHARACTERISTICS OF THE ~~AIRBORNE~~ AIRCRAFT INSTALLATION

6.3.1 *Frequency stability.* The radio frequency of VDL ~~airborne~~ aircraft equipment shall not vary more than plus or minus 0.0005 per cent (5 parts per million) from the assigned frequency.

Note.— The frequency stability for VDL ~~airborne~~ aircraft stations using DSB-AM modulation is specified in Volume III, Part II, Chapter 2 for 25 kHz channel spacing.

6.3.2 *Power.* The effective radiated power shall be such as to provide a field strength of at least 20 microvolts per metre (minus 120 dBW/m^2) ~~(minus 87 dBm)~~ on the basis of free space propagation, at ranges and altitudes appropriate to the operational conditions pertaining to the areas over which the aircraft is operated.

6.3.3 Spurious emissions

6.3.3.1 Spurious emissions shall be kept at the lowest value which the state of the technique and the nature of service permit.

Note.— Appendix 8 to the Radio Regulations contains the tolerances for the levels of spurious emission to which transmitters must conform in accordance with Radio Regulation 304.

6.3.4 Adjacent channel emissions

6.3.4.1 The amount of power from a VDL ~~airborne~~ aircraft transmitter under all operating conditions when measured over the 25 kHz channel bandwidth of the first adjacent channel shall not exceed 0 dBm.

6.3.4.1.1 After 1 January 2002, the amount of power from all new installations of a VDL aircraft transmitter under all operating conditions when measured over the 25 kHz channel bandwidth of the first adjacent channel shall not exceed 2 dBm.

6.3.4.2 The amount of power from a VDL ~~airborne~~ aircraft transmitter under all operating conditions when measured over the 25 kHz channel bandwidth of the second adjacent channel shall be less than minus 25 dBm and from thereon it shall monotonically decrease at the minimum rate of 5 dB per octave to a maximum value of minus 52 dBm.

6.3.4.2.1 After 1 January 2002, the amount of power from all new installations of a VDL aircraft transmitter under all operating conditions when measured over the 25 kHz channel bandwidth of the second adjacent channel shall be less than minus 28 dBm.

6.3.4.2.2 After 1 January 2002, the amount of power from all new installations of a VDL aircraft transmitter under all operating conditions when measured over the 25 kHz channel bandwidth of the fourth adjacent channel shall be less than minus 38 dBm, and from thereon it shall monotonically decrease at the minimum rate of 5 dB per octave to a maximum value of minus 53 dBm.

6.3.4.3 The amount of power from a VDL ~~airborne~~ aircraft transmitter under all operating conditions when measured over a 16 kHz channel bandwidth centred on the first adjacent channel shall not exceed minus 20 dBm.

6.3.4.3.1 After 1 January 2002, the amount of power from all new installations of a VDL aircraft transmitter under all operating conditions when measured over a 16 kHz channel bandwidth centred on the first adjacent channel shall not exceed minus 18 dBm.

6.3.4.4 After 1 January 2005, all VDL aircraft transmitters shall meet the provisions of 6.3.4.1.1, 6.3.4.2.1, 6.3.4.2.2 and 6.3.4.3.1 above, subject to the conditions of 6.3.4.5 below.

6.3.4.5 Requirements of mandatory compliance of the provisions of 6.3.4.4 above shall be made on the basis of regional air navigation agreements which specify the airspace of operation and the implementation timescales. The agreements shall provide at least two years notice of mandatory compliance of aircraft systems.

6.3.5 Receiving function

6.3.5.1 *Specified error rate.* The specified error rate for Mode 2 operation shall be the maximum corrected Bit Error Rate (BER) of 1 in 10^4. The specified error rate for Mode 3 operation shall be the maximum uncorrected BER of 1 in 10^3.

Note.— The above physical layer BER requirements are derived from the BER requirement imposed by ATN at the subnetwork interface.

6.3.5.2 *Sensitivity.* The receiving function shall satisfy the specified error rate with a desired signal strength of not more than 20 microvolts per metre (minus 120 dBW/m^2) ~~(minus 87 dBm)~~.

Note.— The required signal strength at the edge of the service volume takes into account the requirements of the system and signal losses within the system, and considers environmental noise sources.

6.3.5.3 ~~*Undesired signal rejection*~~*Interference immunity performance.* The receiving function shall satisfy the specified error rate with a desired signal field strength of not more than 40 microvolts per metre (minus 114 dBW/m^2) ~~(minus 81 dBm)~~ and with an undesired DSB-AM or D8PSK signal on the adjacent or any other assignable channel being at least 40 dB higher than the desired signal.

~~6.3.5.3.1 **Recommendation.**— *The receiving function should satisfy the specified error rate with a desired signal field strength of not more than 40 microvolts per metre (minus 114 dBW/m2) (minus 81 dBm) and with an undesired signal on the adjacent or any other assignable channel at least 60 dB higher than the desired signal.*~~

6.3.5.3.1 After 1 January 2002, the receiving function of all new installations of VDL shall satisfy the specified error rate with a desired signal field strength of not more than 40 microvolts per metre (minus 114 dBW/m^2) and with an undesired VHF DSB-AM or ~~VDL Mode 2~~ D8PSK signal at least 60 dB higher than the desired signal on any assignable channel 100 kHz or more away from the assigned channel of the desired signal.

Note.— This level of interference immunity performance provides a receiver performance consistent with the influence of the VDL RF spectrum mask as specified in Volume III, Part I, 6.3.4 with an effective isolation transmitter/receiver isolation of 69 dB. Better transmitter and receiver performance could result in less isolation required. Guidance material on the measurement technique is included in Annex 10, Volume V, Attachment A, section 7.

6.3.5.3.2 After 1 January 2005, the receiving function of all installations of VDL shall meet the provisions of 6.3.5.3.1 above, subject to the conditions of 6.3.5.3.3 below.

6.3.5.3.3 Requirements of mandatory compliance of the provisions of 6.3.5.3.2 above shall be made on the basis of regional air navigation agreements which specify the airspace of operation and the implementation timescales. The agreement shall provide for at least two years' notice of mandatory compliance of aircraft systems.

. . .

6.4 PHYSICAL LAYER PROTOCOLS AND SERVICES

The aircraft and ground stations shall access the physical medium operating in simplex mode.

6.4.1 Functions

6.4.1.1 The physical layer shall provide the following functions:

a) transmitter and receiver frequency control;

b) ~~data~~ digital reception by the receiver;

c) ~~data~~ digital transmission by the transmitter; and

d) notification services.

6.4.1.1.1 *Transmitter/receiver frequency control.* The VDL physical layer shall set the transmitter or receiver frequency as commanded by the link management entity (LME).

Note.— The LME is a Link layer entity ~~specified~~ as contained in the Manuals on VDL Mode 2 and VDL Mode 3 Technical Specifications~~6.5~~.

6.4.1.1.2 *~~Data~~ Digital reception by the receiver.* ~~Signals received shall be decoded so that they may be accurately read at the higher layers.~~ The receiver shall decode input signals and forward them to the higher layers for processing.

6.4.1.1.3 *~~Data~~ Digital transmission.* The VDL physical layer shall appropriately encode ~~the data received from the data link layer~~ and transmit ~~it~~ information received from higher layers over the RF channel.

6.4.1.1.4 *Notification services.* The operational parameters of the equipment shall be monitored at the physical layer. Signal quality analysis shall be performed on the demodulator evaluation process and on the receive evaluation process; this analysis shall be normalized between a scale of 0 and 15, where 0 to 3 is considered poor, 4 to 12 is adequate, and 13 to 15 is excellent.

Note.— Processes that may be evaluated in the demodulator include BER, SNR, and timing jitter. Processes that may be evaluated in the receiver include received signal level and group delay.

6.4.1.1.4.1 **Recommendation.—** *The signal quality analysis should be based on received signal strength.*

Editorial Note.— Delete Section 6.4.2 in its entirety and renumber subsequent paragraphs accordingly.

6.4.3 Modes 2 framesand 3 common physical layer

~~6.4.3.1 To transmit a sequence of frames, a station shall insert the bit numbers and flags (per 6.5.3.3.1), compute the FEC (per 6.4.3.1.4), interleave (per 6.4.3.1.5), prepend the training sequence (per 6.4.3.1.3), carry out bit scrambling (per 6.4.3.1.6) and finally encode and modulate the RF signal (per 6.4.3. 1.1).~~

6.4.3.~~1~~.1 *Modulation scheme*. Modes 2 and 3 shall use differentially encoded 8 phase shift keying (D8PSK), using a raised cosine filter with $\alpha = 0.6$ (nominal value). The information to be transmitted shall be differentially encoded with 3 bits per symbol (baud) transmitted as changes in phase rather than absolute phase. The data stream to be transmitted shall be divided into groups of 3 consecutive data bits, least significant bit first. Zeros shall be padded to the end of the transmissions if needed for the final channel symbol.

6.4.3.1.~~1~~.1 *Data encoding*. A binary data stream entering a differential data encoder shall be converted into three separate binary streams X, Y, and Z so that bits 3n form X, bits 3n + 1 form Y, and bits 3n + 2 form Z. The triplet at time k (X_k, Y_k, Z_k) shall be converted to a change in phase as shown in Table 6-1*, and the absolute phase φ_k is the accumulated series of $\Delta\varphi_k$, that is:

$$\varphi_k = \varphi_{k-1} + \Delta\varphi_k$$

6.4.3.1.~~1~~.2 *Transmitted signal form*. The phase-modulated baseband signal as defined in 6.4.3.1.~~1~~.1 shall excite the pulse shape filter.

$$s(t) \sum_{k=-00}^{+00} h(\phi_k, t - kT_3)$$

where:

- h is the complex impulse response of the pulse shape filter;
- k is defined in 6.4.3.1.~~1~~.1;
- Φ is defined by the equation in 6.4.3.1.~~1~~.1;
- t is time;

---

* All tables are located at the end of this chapter.

T_s is time duration of each symbol.

The output (function of time) of the pulse shape filter (S(t)) shall modulate the carrier frequency. The pulse shape filter shall have a nominal complex frequency response of a raised-cosine filter with α=0.6. ~~The spectral mask and the phase mask tolerance are given in Tables 6-2 and 6-3.~~

6.4.3.~~1~~.2 *Modulation rate*. The ~~Mode 2~~ symbol rate shall be 10 500 symbols/second ~~± 0.005 per cent~~, resulting in a nominal bit rate of 31 500 bits/s. The modulation stability requirements for Modes 2 and 3 are provided in Table 6-2.

6.4.4 Mode 2 specific physical layer

The Mode 2 specific specification includes a description of the Mode 2 training sequence, forward error correction (FEC), interleaving, bit scrambling, channel sensing, and physical layer system parameters.

6.4.4.1 To transmit a sequence of frames, a station shall insert the bit numbers and flags (per the data link service description for Mode 2 as contained in the Manual on VDL Mode 2 Technical Specifications), compute the FEC (per 6.4.4.1.2), interleave (per 6.4.4.1.3), prepend the training sequence (per 6.4.4.1.1), carry out bit scrambling (per 6.4.4.1.4) and finally encode and modulate the RF signal (per 6.4.3.1).

~~6.4.3.1.3~~6.4.4.1.1 *Training sequence*. Data transmission shall begin with a demodulator training sequence consisting of five segments:

a) transmitter ramp-up and power stabilization ~~and receiver automatic gain control (AGC) setting~~;

b) synchronization and ambiguity resolution;

c) reserved symbol;

d) transmission length; and

e) header FEC.

Note.— Immediately after these segments, an AVLC frame with the format ~~specified in 6.5.3.3.1~~ as contained in the data link service description in the Manual on VDL Mode 2 Technical Specifications follows.

6.4.4.1.1.1 *Transmitter ramp-up and power stabilization*. The purpose of the first segment of the training sequence, called the ramp-up, is to provide for transmitter power stabilization and receiver AGC settling and it shall immediately precede the first symbol of the unique word. The duration of the ramp-up shall be five symbol periods. The time reference point (t), for the following specification is the center of the first unique word symbol, a point that occurs ½ a symbol period after the end of the ramp-up. Conversely stated, the beginning of the ramp-up starts at t = -5.5 symbol periods. The transmitted power shall be less than -60 dBc prior to time t = -5.5 symbol periods. The ramp-up shall provide that at time t = -3.0 symbol

periods the transmitted power is 90 per cent of the manufacturers stated output power or greater (see Figure 6-1). Regardless of the method used to implement (or truncate) the raised cosine filter, the output of the transmitter between times t = -3.0 and t = -0.5 will appear as if '000' symbols were transmitted during the ramp-up period.

Note. 1.— For Mode 3, the timing reference point is the same as the "power reference point".

Note 2.— It is desirable to maximize the time allowed for the AGC settling time. Efforts should be made to have power above 90 per cent of nominal output power at t - 3.5 symbol periods.

~~6.4.3.1.3.1 *Transmitter power stabilization and receiver AGC setting.* The first segment of the training sequence is the transmitter power stabilization and receiver AGC setting, which shall consist of four symbols each representing 000. The transmitter shall be within 90 per cent of the steady state power level by the end of the transmitter power stabilization segment.~~

~~6.4.3.1.3.1.1 **Recommendation.**— *Although it is necessary to transmit all symbols, it is preferable for transmitters to ramp-up to 90 per cent of steady state in no more than two symbols.*~~

~~6.4.3.1.3.2~~6.4.4.1.1.2 *Synchronization and ambiguity resolution.* The second segment of the training sequence shall consist of the unique word:

000 010 011 110 000 001 101 110 001 100 011
111 101 111 100 010

and shall be transmitted from left to right.

~~6.4.3.1.3.3~~6.4.4.1.1.3 *Reserved symbol.* The third segment of the training sequence shall consist of the single symbol representing 000.

Note.— This field is reserved for future definition.

~~6.4.3.1.3.4~~6.4.4.1.1.4 *Transmission length.* To allow the receiver to determine the length of the final Reed-Solomon block, the transmitter shall send a 17-bit word, from least significant bit (lsb) to most significant bit (msb), indicating the total number of data bits that follow the header FEC.

Note.— The length does not include those bits transmitted for: the Reed Solomon FEC, extra bits padded to ensure that the interleaver generates an integral number of 8-bit words, or the extra bits padded to ensure that the data encoder generates an integral number of 3-bit symbols.

~~6.4.3.1.3.5~~6.4.4.1.1.5 *Header FEC.* To correct bit errors in the header, a (25, 20) block code shall be computed over the reserved symbol and the transmission length segments. The block code shall be transmitted as the fifth segment. The encoder shall accept the header in the bit sequence that is being transmitted. The five parity bits to be transmitted shall be generated using the following equation:

$$[P_1, \ldots, P_5] = [R_1, \ldots, R_3, TL_1, \ldots, TL_{17}]\, H^T$$

where:

P is the parity symbol (P_1 shall be transmitted first);

R is the reserved symbol;

TL is the transmission Length symbol;

^{T} is the matrix transpose function; and

H is the parity matrix defined below:

$$H = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 1 & 1 & 1 \\ 1 & 1 & 0 & 1 & 1 & 0 & 1 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 1 & 1 & 0 & 0 & 1 \\ 0 & 1 & 1 & 0 & 1 & 0 & 0 & 1 & 1 & 1 & 1 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 \end{bmatrix}$$

~~6.4.3.1.3.6~~6.4.4.1.1.6 *Bit transmission order.* The five parity bits of the resultant vector product shall be transmitted from the left bit first.

~~6.4.3.1.4~~6.4.4.1.2 *Forward error correction.* In order to improve the effective channel throughput by reducing the number of required retransmissions, FEC shall be applied after the training sequence, regardless of frame boundaries.

~~6.4.3.1.4.1~~6.4.4.1.2.1 *FEC calculation.* The FEC coding shall be accomplished by means of a systematic fixed-length Reed-Solomon (RS)(255,249) 2^8-ary code.

Note 1.— This code is capable of correcting up to three octets for data blocks of 249 octets (1992 bits). Longer transmissions must be divided up into 1992 bit transmissions and shorter transmissions must be extended by virtual fill with trailing zeros. Six RS-check octets are appended for a total block of 255 octets.

The field defining the primitive polynomial of the code shall be as follows:

$$p(x) = \left(x^8 + x^7 + x^2 + x + 1\right)$$

The generator polynomial shall be as follows:

$$\prod_{i=120}^{125} \left(x - \alpha^i\right)$$

where:

α is a primitive element of GF(256);
GF(256) is a Galois field (GF) of size 256.

Note 2.— The Reed-Solomon codes are described in the Recommendation for Space Data System Standards Telemetry Channel Coding, by the Consultative Committee for Space Data Systems (see the Appendix ~~A~~).

~~6.4.3.1.4.2~~6.4.4.1.2.2 *Block lengths*. The six RS-check octets shall be calculated on blocks of 249 octets. Longer transmissions shall be split into blocks of 249 octets, per 6.4.3.1.5 Blocks of shorter length shall be extended to 249 octets by a virtual fill of trailing zeros. The virtual fill shall not be transmitted. Blocks shall be coded according to 6.4.3.1.4.3 through 6.4.3.1.4.3.3.

~~6.4.3.1.4.3~~6.4.4.1.2.3 *No error correction*. For blocks with 2 or fewer non-fill octets, no error correction shall be used.

~~6.4.3.1.4.3.1~~6.4.4.1.2.3.1 *Single-byte error correction*. For blocks with 3 to 30 non-fill octets, all six RS-check octets shall be generated, but only the first two shall be transmitted. The last four RS-check octets shall be treated as erasures at the decoder.

~~6.4.3.1.4.3.2~~6.4.4.1.2.3.2 *Two-byte error correction*. For blocks with 31 to 67 non-fill octets, all six RS-check octets shall be generated, but only the first four shall be transmitted. The last two RS-check octets shall be treated as erasures at the decoder.

~~6.4.3.1.4.3.3~~6.4.4.1.2.3.3 *Three-byte error correction*. For blocks with 68 or more non-fill octets, all six RS-check octets shall be generated and transmitted.

~~6.4.3.1.5~~6.4.4.1.3 *Interleaving*. To improve the performance of the FEC, an octet-based table-driven interleaver shall be used. The interleaver shall create a table having 255 octets per row and ~~c columns~~ rows, where

$$c = \frac{\textit{transmission length (bits)}}{\textit{1992 (bits)}}$$

where:

a) the transmission length is as defined in ~~6.4.3.1.3.5~~6.4.4.1.1.4; and

b) c = the smallest integer greater than or equal to the value of the fraction.

...

~~6.4.3.1.6~~ 6.4.4.1.4 *Bit scrambling.* To aid clock recovery and to stabilize the shape of the transmitted spectrum, bit scrambling shall be applied. The pseudo noise (PN) sequence shall be a 15-stage generator (see Figure 6-~~1~~2[2]) with the characteristic polynomial:

$$X^{15} + X + 1$$

The PN-sequence shall start after the frame synchronization pattern with the initial value 1101 0010 1011 001 with the left-most bit in the first stage of the register as per Figure 6-~~1~~2. After processing each bit, the register shall be shifted one bit to the right. For possible encryption in the future this initial value shall be programmed. The sequence shall be added (modulo 2) to the data at the transmit side (scrambling) and to the scrambled data at the receive side (descrambling) per Table 6-~~4~~3.

Note.— The concept of a PN scrambler is explained in ~~the International Radio Consultative Committee (CCIR)~~ Report 384-3 ITU-R Recommendation S.446-4, Annex H, Section ~~3~~ 4.3.1, Method 1 (see Appendix A).

~~6.4.3.2~~6.4.4.2 MODE 2 CHANNEL SENSING

~~6.4.3.2.1~~ 6.4.4.2.2 *Channel busy to idle detection.* When a station receives on-channel power of at least -87 dBm for at least 5 milliseconds, then:

. . .

~~6.4.3.2.2~~ 6.4.4.2.2.1 *Channel idle to busy detection.* With a likelihood of at least 0.9, a station shall consider the channel occupied within 1 millisecond after on-channel power rises to at least -90 dBm.

~~6.4.3.2.3~~ 6.4.4.2.3 **Recommendation.—** *The detection of an occupied channel should occur within 0.5 milliseconds.*

Note.— A higher probability of false alarm is acceptable on the idle to busy detection than the busy to idle detection because of the effects of the two different errors.

~~6.4.3.3~~6.4.4.3 MODE 2 RECEIVER/TRANSMITTER INTERACTION

~~6.4.3.3.1~~ 6.4.4.3.1 *Receiver to transmitter turnaround time.* ~~A station shall begin the transmission of the unique word portion of the training sequence within 1 millisecond after terminating the receiver function. The total frequency change during the transmission of the unique word shall be less than 10 Hz. After transmission of the unique word, the phase acceleration shall be less than 500 Hz per second.~~ A station shall transmit the training sequence such that the center of the first symbol of the unique word will be transmitted

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~~1~~2 All figures are located at the end of this chapter.

within 1.25 millisecond after the result of an access attempt is successful (see Figure 6-3). The total frequency change during the transmission of the unique word shall be less than 10 Hz. After transmission of the unique word, the phase acceleration shall be less than 500 Hz per second.

~~6.4.3.3.2~~ 6.4.4.3.2 *Transmitter to receiver turnaround time*. The transmitted power level shall decay at least by 20 dB within 0.3 milliseconds after completing a transmission. A station shall be capable of receiving and demodulating with nominal performance, an incoming signal within 1.5 milliseconds after transmission of the final information symbol.

~~6.4.4~~6.4.4.4 MODE 2 PHYSICAL LAYER SYSTEM PARAMETERS

~~6.4.4.1~~ 6.4.4.4.1 The physical layer shall implement the system parameters as defined in Table 6-~~54~~.

~~6.4.4.1.1~~6.4.4.4.1.1 *Parameter P1 (minimum transmission length)*. Parameter P1 defines the minimum transmission length that a receiver shall be capable of demodulating without degradation of BER.

Insert new text as follows:

6.4.5 Mode 3 specific physical layer

The Mode 3 specific specification includes a description of Mode 3 management (M) burst and handoff check message (H) burst uplink, M burst downlink, voice/data (V/D) burst, and bit scrambling.

6.4.5.1 *Management (M) burst and handoff check message (H) burst uplink.* The M uplink burst (as contained in the *Manual on VDL Mode 3 Technical Specifications*) shall consist of three segments, the training sequence followed by the system data and the transmitter ramp down. The H uplink burst (as contained in the *Manual on VDL Mode 3 Technical Specifications*) shall consist of three segments, the training sequence followed by the handoff check message and the transmitter ramp down.

6.4.5.1.1 *Training sequence.* Uplink M burst and H burst training sequences shall consist of two components as follows:

a) transmitter ramp up and power stabilization; and

b) synchronization and ambiguity resolution.

6.4.5.1.1.1 *Transmitter ramp-up and power stabilization*. This shall be defined in Section 6.4.4.1.1.1.

6.4.5.1.1.2 *Synchronization and ambiguity resolution.* The second component of the training sequence shall consist of the synchronization sequence, known as S_2*, as follows:

000 001 101 100 110 010 111 100 010 011 101 000 111 000 011 001

and shall be transmitted from left to right.

Note.— The sequence S_2 is very closely related to the sequence S_2 (Section 6.4.2.3.2.3.1.2). The 15 phase changes between the 16 symbols of S_2* are each exactly 180° out of phase from the 15 phase changes associated with S_2. This relationship can be used to simplify the process of simultaneously searching for both sequences.*

6.4.5.1.2 *System data and handoff check message.* The non-3T configuration (as contained in the *Manual on VDL Mode 3 Technical Specifications*) system data shall consist of 32 transmitted symbols. The 96 transmitted bits shall include 48 bits of information and 48 parity bits, generated as 4 Golay (24, 12) code words. The 3T configuration as contained in the *Manual on VDL Mode 3 Technical Specifications* shall consist of 128 transmitted symbols. The 384 transmitted bits shall include 192 bits of information and 192 parity bits, generated as 16 Golay (24, 12) code words. The 3T configuration handoff check message shall consist of 40 transmitted symbols. The 120 transmitted bits shall include 60 bits of information and 60 parity bits, generated as 5 Golay (24,12) code words.

The specific definition of the Golay encoder shall be as follows:

If the 12 bit input bit sequence is written as a row vector **x**, then the 24 bit output sequence can be written as the row vector **y**, where **y** = **x** **G**, and the matrix **G** shall be given by

$$\mathbf{G} = \begin{bmatrix}
1&1&0&1&0&1&1&1&0&0&0&1&1&0&0&0&0&0&0&0&0&0&0&0\\
0&1&1&1&1&1&0&0&1&0&0&1&0&1&0&0&0&0&0&0&0&0&0&0\\
1&1&1&0&1&0&0&1&0&1&0&1&0&0&1&0&0&0&0&0&0&0&0&0\\
0&1&1&0&0&0&1&1&1&0&1&1&0&0&0&1&0&0&0&0&0&0&0&0\\
1&1&1&0&0&1&1&0&1&1&0&0&0&0&0&0&1&0&0&0&0&0&0&0\\
1&0&1&1&0&0&1&1&0&1&1&0&0&0&0&0&0&1&0&0&0&0&0&0\\
1&0&0&1&1&0&0&1&1&0&1&1&0&0&0&0&0&0&1&0&0&0&0&0\\
0&1&0&1&1&0&1&1&1&1&0&0&0&0&0&0&0&0&0&1&0&0&0&0\\
0&0&1&0&1&1&0&1&1&1&1&0&0&0&0&0&0&0&0&0&1&0&0&0\\
0&0&0&1&0&1&1&0&1&1&1&1&0&0&0&0&0&0&0&0&0&1&0&0\\
1&1&0&1&1&1&0&0&0&1&1&0&0&0&0&0&0&0&0&0&0&0&1&0\\
1&0&1&0&1&1&1&0&0&0&1&1&0&0&0&0&0&0&0&0&0&0&0&1
\end{bmatrix}$$

Note.— The extended Golay code allows for the correction of any error pattern with 3 or fewer bit errors and the detection of any 4-bit error pattern.

6.4.5.1.3 *Transmitter ramp-down.* Following the end of the final symbol, the transmitter power shall be below -20 dBc within 2 symbol periods. The transmitter power leakage when the transmitter is in the "off" state shall be less than -83 dBm.

Note.— Reference RTCA/DO-160D section 21, category H for antenna radiated signals.

6.4.5.2 *Management (M) burst downlink.* The M downlink burst (as contained in the *Manual on VDL Mode 3 Technical Specifications*) shall consist of three segments, the training sequence followed by the system data and the transmitter ramp down.

6.4.5.2.1 *Training sequence.* The M downlink burst training sequence shall consist of two components as follows:

a) transmitter ramp up and power stabilization; and

b) synchronization and ambiguity resolution.

6.4.5.2.1.1 *Transmitter ramp-up and power stabilization.* This shall be as defined in Section 6.4.5.1.1.1.

6.4.5.2.1.2 *Synchronization and ambiguity resolution.* Three separate synchronization sequences shall be used for this burst type. The standard sequence, known as S_1, shall be as follows:

000 111 001 001 010 110 000 011 100 110 011 111 010 101 100 101

and shall be transmitted from left to right. The special sequence used to identify poll responses shall be as defined in Section 6.4.5.1.1.2.

The special sequence used to identify net entry requests (S_1*) shall use the following sequence:

000 001 111 111 100 000 110 101 010 000 101 001 100 011 010 011

and shall be transmitted from left to right.

Note.— The sequence S_1 is very closely related to the sequence S_1. The 15 phase changes between the 16 symbols of S_1* are each exactly 180° out of phase from the 15 phase changes associated with S_1. This relationship can be used to simplify the process of simultaneously searching for both sequences.*

6.4.5.2.2 *System data.* The system data segment shall consist of 16 transmitted symbols. The 48 transmitted bits shall be encoded as 24 bits of system data and 24 bits of parity bits generated as two consecutive (24, 12) Golay code words. The encoding of the (24, 12) Golay code words should be as defined in Section 6.4.5.1.2.

6.4.5.2.3 *Transmitter ramp-down.* This shall be as defined in Section 6.4.5.1.3.

6.4.5.3 *Voice or data (V/D) burst.* The V/D burst (as contained in the *Manual on VDL Mode 3 Technical Specifications*) shall consist of four segments: the training sequence followed by the header, the user information segment and the transmitter ramp down. The same V/D burst format shall be used for both uplink and downlink.

6.4.5.3.1 *Training sequence.* V/D burst training sequence shall consist of two components as follows:

a) transmitter ramp-up and power stabilization; and

b) synchronization and ambiguity resolution.

6.4.5.3.1.1 *Transmitter ramp-up and power stabilization.* This shall be as specified in Section 6.4.5.1.1.1.

6.4.5.3.1.2 *Synchronization and ambiguity resolution.* The second component of the training sequence shall consist of the synchronization sequence-known as S_2, as follows:

000 111 011 010 000 100 001 010 100 101 011 110 001 110 101 111

and shall be transmitted from left to right.

6.4.5.3.2 *Header.* The header segment shall consist of 8 transmitted symbols. The 24 transmitted bits shall be encoded as 12 bits of header information and 12 parity bits, generated as a single (24, 12) Golay code word. The encoding of the (24, 12) Golay code word shall be as defined in Section 6.4.5.1.2.

6.4.5.3.3 *User information.* The user information segment shall consist of 192 3-bit symbols. When transmitting voice, FEC shall be applied to the analysis output of the vocoder specified in Section 6.8. The vocoder shall provide satisfactory performance in a BER environment of 10^{-3} (with a design goal of 10^{-2}). The overall bit rate of the vocoder *including FEC* is 4 800 bits/s (except when in the truncated mode in which the bit rate is 4 000 bits/s).

When transmitting user data, the 576 bits shall be encoded as a single Reed-Solomon (72, 62) 2^8-ary code word. For user data input to the Reed-Solomon encoder of length less than 496 bits, input data shall be padded with zeroes at the end to a full length of 496 bits. The field defining the primitive polynomial of the code shall be as described in Section 6.4.3.3.1.3.1. The generator polynomial shall be as follows:

$$\prod_{i=120}^{129} (x - \alpha^i)$$

Note.— The Reed-Solomon (72, 62) code is capable of correcting up to five 2^8-ary (code word) symbol errors in the received word.

6.4.5.3.4 *Transmitter ramp-down.* This shall be as defined in Section 6.4.5.1.3.

6.4.5.4 *Interleaving.* There shall be no interleaving in Mode 3 operation.

6.4.5.5 *Bit scrambling.* Under Mode 3 operation, bit scrambling, as specified in Section 6.4.4.1.4 shall be performed on each burst, starting after the training sequence. The scrambling sequence shall be reinitialized on each burst effectively providing a constant overlay for each of the Mode 3 fixed length bursts.

6.4.5.6 *Receiver/transmitter interaction.* The switching times in this subsection will be defined as the time between the middle of the last information symbol of one burst and the middle of the first symbol of the synchronization sequence of the subsequent burst.

Note.— This nominal time will be shortened by considerations such as the finite width of each symbol due to Nyquist filtering and the ramp up and power stabilization sequence. Such alternative definitions could yield switching times up to 8 symbol periods shorter.

6.4.5.6.1 *Receiver to transmitter switching time.* An aircraft radio shall be capable of switching from reception to transmission within 17 symbol periods. This time can be relaxed to 33 symbol periods for aircraft radios which do not implement functions requiring discrete addressing.

Note 1.— The shortest R/T switching time for an aircraft radio occurs when the reception of an uplink M channel beacon is followed by a V/D transmission in the same slot. In certain instances where aircraft radios do not implement functions requiring discrete addressing, the R/T switching time can be increased since the last two Golay words of the uplink M channel beacon need not be read.

Note 2.— The minimum turnaround time assumes that in configurations 3V1D, 2V1D, and 3T (as contained in Section 5.5.2.4 of the Manual on VDL Mode 3 Technical Specifications*), the aircraft radios will be provided with software that will prevent them from transmitting a downlink M channel message in a slot following the reception of a voice message from another aircraft with a long time delay.*

6.4.5.6.2 *Transmitter to receiver switching time.* An aircraft radio shall be capable of switching from transmission to reception within 32 symbol periods.

Note.— The worst case T/R switching time for an aircraft radio occurs when it transmits a downlink M channel message and receives a V/D message in the same slot.

6.4.5.7 *Fringe coverage indication.*

6.4.5.7.1 **Recommendation.**— *Indication of near edge-of-coverage should be provided to the VDL Mode 3 aircraft.*

End of new text.

6.5 LINK LAYER PROTOCOLS AND SERVICES

6.5.1 General information

6.5.1.1 *Functionality.* The ~~VHF digital link (~~VDL~~)~~ link layer shall provide the following sub-layer functions:

a) media access control (MAC) sub-layer, which requires the use of the carrier sense multiple access (CSMA) algorithm for Mode 2 or TDMA for Mode 3;

b) a data link service (DLS) sub-layer:

i) for Mode 2, the DLS sub-layer ~~providing~~ provides connection-oriented point-to-point links using data link entities (DLE) and connection-less broadcast link over the MAC sub-layer; and

ii) for Mode 3, the DLS sub-layer provides acknowledged connectionless point-to-point and point-to-multipoint links over a MAC sublayer that guarantees sequencing; and

c) a VDL management entity (VME), which establishes and maintains DLEs between the aircraft and the ground-based systems using link management entities (LME).

6.5.1.2 SERVICE

6.5.1.2.1 *Connection-oriented.* The VDL Mode 2 link layer shall provide a reliable point-to-point service using a connection-oriented DLS sub-layer.

6.5.1.2.2 *Connection-less.* The VDL Mode 2 and 3link layers shall provide an unacknowledged broadcast service using a connection-less DLS sub-layer.

6.5.1.2.3 *Acknowledged connection-less.* The VDL Mode 3 link layer shall provide an acknowledged point-to-point service using a connection-less DLS sublayer that relies upon the MAC sublayer to guarantee sequencing.

6.5.2 MAC sub-layer

6.5.2.1 The MAC sub-layer shall provide for the transparent acquisition of the shared communications path. It makes invisible to the DLS sub-layer the way in which supporting communications resources are utilized to achieve this.

Note.— Specific MAC services and procedures for VDL Modes 2 and 3 are contained in the Manuals on VDL Mode 2 and VDL Mode 3 Technical Specifications.

~~*Note.— The service specification for the MAC sub-layer is modeled on the MAC Service Definition (ISO DP 10039).*~~

Editorial Note.— Delete Sections 6.5.2.2 to 6.5.2.4 in their entirety.

6.5.3 Data link service sub-layer

6.5.3.1 For Mode 2, ~~T~~the DLS shall support bit-oriented simplex air-ground communications using the aviation VHF link control (AVLC) protocol ~~specified in this section~~.

Note.— Specific data link services, parameters, and protocol definitions for VDL Mode 2 are contained in the Manual on VDL Mode 2 Technical Specifications.

~~*Note.— The DLS is derived from HDLC, as specified by ISO 3309, ISO 4335, ISO 7809, and ISO 8885. Any definitions of service are derived from the OSI Data Link Service Definition ISO 8886.3. AVLC is a variant of HDLC and derived from, but is not fully specified by, options 1, 3.2, 4, 7, and 12 of ISO 7809. Explicit references to these documents are made later in this section.*~~

6.5.3.2 For Mode 3, the DLS shall support bit-oriented, priority based, simplex air-ground communications using the acknowledged connectionless data link (A-CLDL) protocol.

Note.— Specific data link services, parameter, and protocol definitions for VDL Mode 3 are contained in the Manual on VDL Mode 3 Technical Specifications.

Editorial Note.— Delete Sections 6.5.3.2, 6.5.3.3, 6.5.3.4, 6.5.3.5, 6.5.3.6, 6.5.3.7, 6.5.3.8, 6.5.3.9, 6.5.3.10 and 6.5.3.11 in their entirety.

6.5.4 VDL management entity

6.5.4.1 *Services.* The VME shall provide link establishment, maintenance and disconnection services as well as support parameter modification. Specific VME services, parameter formats, and procedures for Modes 2 and 3 are contained in the *Manuals on VDL Mode 2 and Mode 3 Technical Specifications*.

Editorial Note.— Delete Sections 6.5.4.1, 6.5.4.2, 6.5.4.3 and 6.5.4.4 in their entirety.

6.6 SUBNETWORK LAYER PROTOCOLS AND SERVICES

6.6.1 Architecture for Mode 2

6.6.1.1 The subnetwork layer protocol used across the VHF air-ground subnetwork for VDL Mode 2 is referred to formally as a subnetwork access protocol (SNAcP) and shall conform to ISO 8208, except as ~~noted below~~contained in the *Manual on VDL Mode 2 Technical Specifications*. The SNAcP is contained ~~referred to~~ within ~~this document~~ the *Manual on VDL Mode 2 Technical Specifications* as the subnetwork protocol. If there are any differences between ~~this document~~the *Manual on VDL Mode 2 Technical Specifications* and the cited specifications, ~~this document~~the *Manual on VDL Mode 2 Technical Specifications* shall have precedence. On the air-ground interface, the aircraft subnetwork entity shall act as a DTE and the ground subnetwork entity shall act as a DCE.

Note.— Specific subnetwork layer protocol access points, services, packet formats, parameters and procedures for VDL Mode 2 are contained in the Manual on VDL Mode 2 Technical Specifications.

~~6.6.1.1 *Access points*. The subnetwork service access point (SNSAP) shall be uniquely identified by the subnetwork data terminal equipment (DTE) address. SNSAPs shall define the subnetwork point of attachment (SNPA) used by the service primitives that define the subnetwork service to the subnetwork dependence convergence protocol.~~

6.6.2 Architecture for Mode 3

6.6.2.1 The subnetwork layer used across the VHF air-ground subnetwork for VDL Mode 3 provides the flexibility to simultaneously support multiple subnetwork protocols. The currently defined options are to support ISO 8473 connectionless network protocol and to support ISO 8208, both as contained in the *Manual on VDL Mode 3 Technical Specifications*. The *Manual on VDL Mode 3 Technical Specifications* shall have precedence with respect to any differences with the cited specifications. For the ISO 8208 interface, both the air and ground subnetwork entities shall act as DCEs.

Note.— Specific subnetwork layer protocol access points, services, packet formats, parameters and procedures for VDL Mode 3 are contained in the Manual on VDL Mode 3 Technical Specifications.

Editorial Note.— Delete Sections 6.6.2, 6.6.3, 6.6.4, 6.6.5 and 6.6.6 in their entirety.

6.7 THE VDL MOBILE SUBNETWORK DEPENDENT CONVERGENCE FUNCTION (SNDCF)

6.7.1 VDL Mode 2 SNDCF

6.7.1.1 *Introduction.* The VDL Mode 2 mobile SNDCF shall be the standard mobile SNDCF.

6.7.1.2 *New function.* The VDL Mode 2 mobile SNDCF shall support maintaining context (e.g. compression tables) across subnetwork calls. The SNDCF shall use the same context (e.g. compression tables) across all SVCs negotiated to a DTE, when negotiated with the same parameters. The SNDCF shall support at least 2 SVCs sharing a context.

Note.— Because handoffs can be expected to reorder packets, certain compression algorithms do not lend themselves to use over ~~the~~ VDL Mode 2. Further, implementors of dictionary-based compression algorithms must be sensitive to the problem of updates arriving on either the old or newly established call.

~~*6.7.1.3 Call user data encoding*~~*Note.— The encoding of the Call User Data field ~~shall be as detailed~~ is described in the ~~ATN Manual~~* Manual of Technical Provisions for the Aeronautical Telecommunication Network *(ATN) (Doc 9705), except ~~as modified below~~ with modifications as contained in the* Manual on VDL Mode 2 Technical Specifications.

Editorial Note.— Delete existing Sections 6.7.3.1 to 6.7.3.4

Insert new text as follows:

6.7.2 VDL Mode 3 SNDCF

6.7.2.1 The VDL Mode 3 shall support one or more of the defined SNDCFs. The first is the standard ISO 8208 SNDCF as defined in the *Manual of Technical Provisions for the Aeronautical Telecommunication Network (ATN)* (Doc 9705). This is a connection-oriented SNDCF. The second type of SNDCF supported by VDL Mode 3 is denoted frame-based SNDCF. The details of this connection-less oriented SNDCF are contained in the *Manual on VDL Mode 3 Technical Specifications*, including network layer interface, support for broadcast and unicast network packets, and ATN router support.

Note.— The framed-based SNDCF is termed such because it uses the VDL Mode 3 frames without the need for an additional protocol (viz. ISO 8208 SNDCF) to transfer network packets. The frame-based SNDCF achieves independence from the network protocol by identifying the payload of each frame. Upon receipt of a frame, the payload is examined and control is passed to the protocol identified.

6.8 VOICE UNIT FOR MODE 3

6.8.1 Services

6.8.1.1 The voice unit shall provide for a simplex, "push-to-talk" audio and signalling interface between the user and the VDL. Two separate mutually exclusive voice circuit types shall be supported.

a) Dedicated circuits: This shall provide service to a specific user group on an exclusive basis with no sharing of the circuit with other users outside the group. Access shall be based on a "listen-before-push-to-talk" discipline.

b) Demand assigned circuits: This shall provide voice circuit access which is arbitrated by the ground station in response to an access request received from the aircraft station. This type of operation shall allow dynamic sharing of the channel resource increasing trunking efficiency.

6.8.1.2 *Priority access.* The voice unit operation shall support a priority override access for authorized ground users.

6.8.1.3 *Message source identification.* The voice unit operation shall support notification to the user of the source of a received message (i.e. whether the message originated from an air or ground station).

6.8.1.4 *Coded squelch.* The voice unit shall support a coded squelch operation that offers some degree of rejection of undesired cochannel voice messages based on the burst time of arrival.

6.8.2 Speech encoding, parameters, and procedures

6.8.2.1 The VDL Mode 3 shall use the augmented multiband excitation (AMBE) 4.8 kbits/s encoding/decoding algorithm, version number AMBE-ATC-10, developed by Digital Voice Systems, Incorporated (DVSI) for voice communications.

Note 1.— Information on technical characteristics of the 4.8 kbits/s AMBE algorithm is contained in AMBE-ATC-10 Low Level Description, obtainable from DVSI.

Note 2.— The 4.8 kbits/s AMBE encoding/decoding technology described in the document is subject to DVSI patent rights and copyrights. Manufacturers must enter into a license agreement with DVSI prior to obtaining a detailed description of the algorithm before incorporation in equipment operating in the VDL Mode 3 service. By letter to ICAO dated 29 October 1999, DVSI confirmed its commitment to license the technology for the manufacture and sale of aeronautical equipment under reasonable terms and conditions, negotiated on a non-discriminatory basis.

6.8.2.2 Speech encoding definition, voice unit parameters, and procedure descriptions for VDL Mode 3 Voice Unit operation are contained in the *Manual on VDL Mode 3 Technical Specifications.*

6.9 VDL MODE 4

6.9.1 A Mode 4 station shall conform to the requirements defined in sections 6.1.4.2, 6.2.1.1, 6.2.3.1, 6.2.4, 6.3.1, 6.3.3.1, 6.3.4, 6.3.5.2, 6.3.5.3, 6.3.5.4 and 6.9.

6.9.2 VDL Mode 4 radio channels

6.9.2.1 VDL MODE 4 STATION FREQUENCY RANGE

6.9.2.1.1 *Transmitter/receiver tuning range.* A VDL Mode 4 transmitter/receiver shall be capable of tuning to any of the 25 kHz channels from 117.975 MHz through 137 MHz. The transmitter shall have a means for the tuning range to be restricted to a narrower range.

Note.— Operational conditions or certain applications may require the equipment to be operated in a narrower frequency range.

6.9.2.1.2 **Recommendation.**— *A VDL Mode 4 transmitter/receiver should be capable of tuning to any of the 25 kHz channels from 108 to 117.975 MHz.*

Note.— The band 108 - 117.975 MHz may be utilized in some States for ADS applications.

6.9.2.1.3 *Simultaneous reception.* A VDL Mode 4 station shall be capable of receiving two channels simultaneously.

6.9.2.1.4 **Recommendation.**— *A VDL Mode 4 station should be capable of receiving additional channels simultaneously as required by operational services.*

6.9.2.2 GLOBAL SIGNALLING CHANNELS

6.9.2.2.1 VDL Mode 4 stations shall use two assigned frequencies as global signalling channels (GSC), to support user communications and link management functions.

Note.— Additional channels may be defined in a local domain, and notified to mobile users by broadcast from ground stations on the GSCs defined above.

6.9.3 System capabilities

6.9.3.1 *ATN compatibility.* The VDL Mode 4 system shall support ATN-compliant subnetwork services for surveillance applications.

6.9.3.2 *Data transparency.* The VDL Mode 4 system shall provide code-independent, byte-independent transfer of data.

6.9.3.3 *Broadcast.* The VDL Mode 4 system shall provide link layer broadcast services.

6.9.3.4 *Point-to-point.* The VDL Mode 4 system shall provide link layer point-to-point services.

6.9.3.5 *Air-air communications.* The VDL Mode 4 system shall provide air-air communications, without ground support, as well as air-ground communications.

6.9.3.6 *Connection management.* When supporting air-ground operations, the VDL Mode 4 system shall establish and maintain a reliable communications path between the aircraft and the ground system while allowing, but not requiring, manual intervention.

6.9.3.7 *Ground network transition.* A mobile VDL Mode 4 DLS station shall transition from one ground VDL Mode 4 DLS station to another as required.

6.9.3.8 *Derived time capability.* VDL Mode 4 shall provide the capability for deriving time from time-of-arrival measurements of received VDL Mode 4 transmissions whenever externally derived estimates of time are unavailable.

6.9.3.9 *Simplex operations.* Mobile and ground VDL Mode 4 stations shall access the physical medium operating in simplex mode.

6.9.4 Coordination of channel utilization

6.9.4.1 On a regional basis, transmissions shall be scheduled relative to UTC, to ensure efficient use of shared channels and to avoid unintentional slot re-use.

6.9.5 Physical layer protocols and services

Note.— Unless otherwise stated, the requirements defined in this section apply to both mobile and ground stations.

6.9.5.1 FUNCTIONS

6.9.5.1.1 TRANSMITTED POWER

6.9.5.1.1.1 *Airborne installation.* On a high percentage of occasions, the effective radiated power shall be such as to provide a field strength of at least 35 microvolts per metre (minus 114.5 dBW/m^2) on the basis of free space propagation, at ranges and altitudes appropriate to the conditions pertaining to the areas over which the aircraft is operated.

6.9.5.1.1.2 *Ground installation.*

Recommendation.— *The effective radiated power should be such as to provide a field strength of at least 75 microvolts per metre (minus 109 dBW/m^2) within the defined operational coverage of the facility, on the basis of free-space propagation.*

6.9.5.1.2 TRANSMITTER AND RECEIVER FREQUENCY CONTROL

6.9.5.1.2.1 The VDL Mode 4 physical layer shall set the transmitter or receiver frequency as commanded by the link management entity (LME). Channel selection time shall be less than 13 ms after the receipt of a command from a VSS user.

6.9.5.1.3 DATA RECEPTION BY RECEIVER

6.9.5.1.3.1 The receiver shall decode input signals and forward them to the higher layers for processing.

6.9.5.1.4 DATA TRANSMISSION BY TRANSMITTER

6.9.5.1.4.1 *Data encoding and transmission.* The physical layer shall encode the data received from the data link layer and transmit it over the RF channel. RF transmission shall take place only when permitted by the MAC.

6.9.5.1.4.2 *Order of transmission.* The transmission shall consist of the following stages in the following order:

a) transmitter power stabilization;

b) bit synchronization;

c) ambiguity resolution and data transmission; and

d) transmitter decay.

Note.— The definitions of the stages are given in Sections 6.9.5.2.3.1 to 6.9.5.2.3.4.

6.9.5.1.4.3 *Automatic transmitter shutdown.* A VDL Mode 4 station shall automatically shut-down power to any final stage amplifier in the event that output power from that amplifier exceeds -30 dBm for more than 1 second. Reset to an operational mode for the affected amplifier shall require a manual operation.

Note.— This is intended to protect the shared channel resource against so-called "stuck transmitters".

6.9.5.1.5 NOTIFICATION SERVICES

6.9.5.1.5.1 *Signal quality.* The operational parameters of the equipment shall be monitored at the physical layer. Signal quality analysis shall be performed in the demodulator process and in the receive process.

Note.— Processes that may be evaluated in the demodulator include bit error rate (BER), signal to noise ratio (SNR), and timing jitter. Processes that may be evaluated in the receiver include received signal level and group delay.

6.9.5.1.5.2 *Arrival time.* The arrival time of each received transmission shall be measured with a two-sigma error of 5 microseconds.

6.9.5.1.5.3 **Recommendation.**— *The receiver should be capable of measuring the arrival time within a two-sigma error of 1 microsecond.*

6.9.5.2 PROTOCOL DEFINITION FOR GFSK

6.9.5.2.1 *Modulation scheme.* The modulation scheme shall be GFSK. The first bit transmitted (in the training sequence) shall be a high tone and the transmitted tone shall be toggled before transmitting a 0 (i.e. non-return to zero inverted encoding).

6.9.5.2.2 *Modulation rate.* Binary ones and binary zeros shall be generated with a modulation index of 0.25 ± 0.03 and a BT product of 0.28 ± 0.03, producing data transmission at a bit rate of 19 200 bits/s ± 50 ppm.

6.9.5.2.3 STAGES OF TRANSMISSION

6.9.5.2.3.1 *Transmitter power stabilization.* The first segment of the training sequence is the transmitter power stabilization, which shall have a duration of 16 symbol periods. The transmitter power level shall be no less than 90 per cent of the steady state power level at the end of the transmitter power stabilization segment.

6.9.5.2.3.2 *Bit synchronization.* The second segment of the training sequence shall be the 24-bit binary sequence 0101 0101 0101 0101 0101 0101, transmitted from left to right immediately before the start of the data segment.

6.9.5.2.3.3 *Ambiguity resolution and data transmission.* The transmission of the first bit of data shall start 40 bit intervals (approximately 2083.3 microsecond) ± 1 microsecond after the nominal start of transmission.

Note 1.— This is referenced to emissions at the output of the antenna.

Note 2.— Ambiguity resolution is performed by the link layer.

6.9.5.2.3.4 *Transmitter decay.* The transmitted power level shall decay at least by 20 dB within 300 microsecond after completing a transmission. The transmitter power level shall be less than -90 dBm within 832 microsecond after completing a transmission.

6.9.5.3 CHANNEL SENSING

6.9.5.3.1 *Estimation of noise floor.* A VDL Mode 4 station shall estimate the noise floor based on power measurements of the channel whenever a valid training sequence has not been detected.

6.9.5.3.2 The algorithm used to estimate the noise floor shall be such that the estimated noise floor shall be lower than the maximum power value measured on the channel over the last minute when the channel is regarded as idle.

Note.— The VDL Mode 4 receiver uses an energy sensing algorithm as one of the means to determine the state of the channel (idle or busy). One algorithm that can be used to estimate the noise floor is described in the Manual on VDL Mode 4 Technical Specifications.

6.9.5.3.3 *Channel idle to busy detection.* A VDL Mode 4 station shall employ the following means to determine the channel idle to busy transition at the physical layer.

6.9.5.3.3.1 *Detection of a training sequence.* The channel shall be declared busy if a VDL Mode 4 station detects a valid training sequence followed by a frame flag.

6.9.5.3.3.2 *Measurement of channel power.* Regardless of the ability of the demodulator to detect a valid training sequence, a VDL Mode 4 station shall consider the channel busy with at least a 95 per cent probability within 1 ms after on-channel power rises to the equivalent of at least four times the estimated noise floor for at least 0.5 milliseconds.

6.9.5.3.4 *Channel busy to idle detection*

6.9.5.3.4.1 A VDL Mode 4 station shall employ the following means to determine the channel busy to idle transition.

6.9.5.3.4.2 *Measurement of transmission length.* When the training sequence has been detected, the channel busy state shall be held for a period of time at least equal to 5 millisecond, and subsequently allowed to transition to the idle state based on measurement of channel power.

6.9.5.3.4.3 *Measurement of channel power.* When not otherwise held in the channel busy state, a VDL Mode 4 station shall consider the channel idle with at least a 95 per cent probability if on-channel power falls below the equivalent of twice the estimated noise floor for at least 0.9 millisecond.

6.9.5.4 RECEIVER/TRANSMITTER INTERACTION

6.9.5.4.1 *Receiver to transmitter turnaround time.* A VDL Mode 4 station shall be capable of beginning the transmission of the transmitter power stabilization sequence within 16 microseconds after terminating the receiver function.

6.9.5.4.2 *Frequency change during transmission.* The phase acceleration of the carrier from the start of the synchronization sequence to the data end flag shall be less than 300 Hz per second.

6.9.5.4.3 *Transmitter to receiver turnaround time.* A VDL Mode 4 station shall be capable of receiving and demodulating with nominal performance an incoming signal within 1 ms after completing a transmission.

Note.— Nominal performance is defined as a BER of 10^{-4}.

6.9.5.5 PHYSICAL LAYER SYSTEM PARAMETERS

6.9.5.5.1 *Parameter P1 (minimum transmission length)*

6.9.5.5.1.1 The parameter P1 shall be the minimum transmission length that a receiver shall be capable of demodulating without degradation of BER.

6.9.5.5.1.2 The value of P1 shall be 19 200 bits.

6.9.5.5.2 *Parameter P2 (nominal co-channel interference performance)*

6.9.5.5.2.1 The parameter P2 shall be the nominal co-channel interference at which a receiver shall be capable of demodulating without degradation in BER for a desired signal which arrives prior to an interfering signal.

6.9.5.5.2.2 The value of P2 shall be 12 dB.

6.9.6 Link layer

Note.— Details on link layer functions are contained in the Manual on VDL Mode 4 Technical Specifications.

6.9.7 Subnetwork layer

Note.— Details on subnetwork layer functions are contained in the Manual on VDL Mode 4 Technical Specifications.

6.9.8 ADS-B applications

Note.— Details on ADS-B application functions are contained in the Manual on VDL Mode 4 Technical Specifications.

End of new text.

TABLES FOR CHAPTER 6

Table 6-1. Modes 2 and 3 data encoding

X_k	Y_k	Z_k	$\Delta\varphi_k$
0	0	0	$0\,\pi/4$
0	0	1	$1\,\pi/4$
0	1	1	$2\,\pi/4$
0	1	0	$3\,\pi/4$
1	1	0	$4\,\pi/4$
1	1	1	$5\,\pi/4$
1	0	1	$6\,\pi/4$
1	0	0	$7\,\pi/4$

~~**Table 6-2. Spectral mask of transmitter for D8PSK**~~

~~LOWER BOUND~~		~~UPPER BOUND~~	
~~Frequency Deviation~~	~~Attenuation~~	~~Frequency Deviation~~	~~Attenuation~~
~~0~~	~~-0.25~~	~~0~~	~~0.25~~
~~1700~~	~~-0.25~~	~~2500~~	~~0.25~~
~~3000~~	~~-1~~	~~3900~~	~~-1~~
~~3900~~	~~-3~~	~~4900~~	~~-3~~
~~4800~~	~~-6~~	~~5800~~	~~-6~~
~~5350~~	~~-10~~	~~6650~~	~~-10~~
~~6310~~	~~-20~~	~~7910~~	~~-20~~
~~6680~~	~~-30~~	~~8680~~	~~-30~~

~~*Note.— Frequency deviation from the channel centre (on both sides) is specified in Hz, and the attenuation is specified in dBc.*~~

~~**Table 6-3. Tolerance on the phase mask of transmitter for D8PSK**~~

~~LOWER BOUND~~		~~UPPER BOUND~~	
~~Frequency Deviation~~	~~Phase~~	~~Frequency deviation~~	~~Phase~~
~~0~~	~~-1.8~~	~~0~~	~~1.8~~
~~5250~~	~~-1.8~~	~~5250~~	~~1.8~~
~~5250~~	~~-2.8~~	~~5250~~	~~2.8~~
~~6000~~	~~-2.8~~	~~6000~~	~~2.8~~
~~6000~~	~~-180~~	~~6000~~	~~180~~

~~*Note.— Frequency deviation from the channel centre (on both sides) is specified in Hz, and the phase is specified in degrees deviation from linear.*~~

Table 6-2. Modes 2 and 3 modulation stability

VDL Mode	Aircraft Modulation Stability	Ground Modulation Stability
Mode 2	± 0.0050 per cent	± 0.0050 per cent
Mode 3	± 0.0005 per cent	± 0.0002 per cent

Table 6-43. Scrambler functions

Function	Data in	Data out
Scrambling	clean data	scrambled data
Descrambling	Scrambled data	clean data

Table 6-54. Physical services system parameters

Symbol	Parameter name	~~Mode 1 value~~	Mode 2 value
P1	Minimum transmission length	~~16504 bits~~	131071 bits

...

Insert new figure as follows:

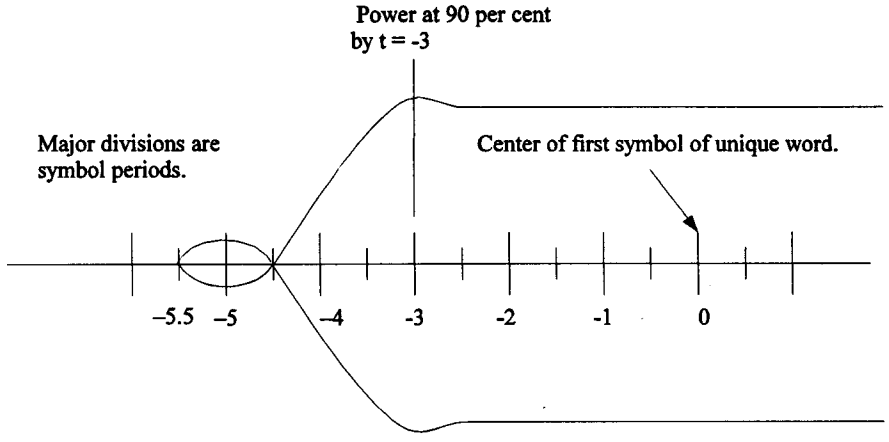

Figure 6-1. Transmitter Power Stabilization

End of new figure.

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Delete existing Figure 6-2:

~~**Figure 6-2. Link layer frame format**~~

Figure ~~6-16-2~~. PN-generator for bit scrambling sequence

Insert new figure as follows:

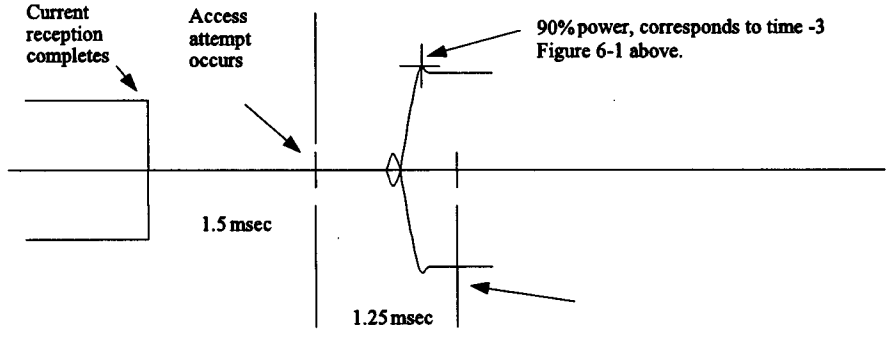

Figure 6-3. Receive to Transmit Turnaround Time

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ATTACHMENT C to State letter AN 7/1.3.81-00/70

PROPOSED AMENDMENT TO ANNEX 10, VOLUME III, PART I, CHAPTER 12

(AMSS; ALTERNATIVE PROVISIONS)

NOTES ON THE PRESENTATION OF THE AMENDMENT TO ANNEX 10

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INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

AERONAUTICAL TELECOMMUNICATIONS

ANNEX 10
TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

VOLUME III — COMMUNICATION SYSTEMS

(PART I — DIGITAL DATA COMMUNICATION SYSTEMS)

. . .

Insert new text as follows:

CHAPTER 12. ALTERNATIVE PROVISIONS FOR AERONAUTICAL MOBILE SATELLITE (R)* SERVICE

Note 1.— This chapter contains Standards and Recommended Practices applicable to the use of next-generation satellite system (NGSS) communications technologies to support the aeronautical mobile-satellite (R) service (AMS(R)S). The Standards and Recommended Practices of this chapter are service- and performance-oriented and are not tied to a specific technology or technique. They are intended to provide alternative means of meeting AMS(R)S requirements, independent of the Standards and Recommended Practices of Annex 10, Part I, Volume III, Chapter 4.*

Note 2.— Multiple service providers may offer AMS(R)S, either according to the Standards and Recommended Practices of Annex 10, Part I, Volume III, Chapter 4 or according to those of this chapter.

Note 3.— Additional information and guidance is provided in the Manual on Alternative Provisions for AMS(R)S.

12.1 DEFINITIONS

Next-generation satellite system (NGSS). A satellite communications system that provides AMS(R)S in conformance with the provisions of this chapter. These services can be voice, or data, or both. An NGSS may provide non-AMS(R)S communications. An NGSS includes AESs, satellites, GESs and network control system facilities that perform administrative and operational management functions.

* route

Satellite system service area. A portion of the Earth's surface within which a satellite-based communications system satisfies the standards of this chapter. Depending on its design, a system may provide discontinuous service areas.

Note.— The following terms used in this chapter are defined elsewhere in Annex 10:

Aircraft earth station (AES): defined in Annex 10, Volume III, Chapter 1.
Aeronautical telecommunication network (ATN): defined in Annex 10, Volume III, Chapter 1.
Aeronautical mobile-satellite service (AMSS): defined in Annex 10, Volume II, Chapter 1.1.
Aeronautical mobile-satellite (R) service (AMS(R)S): defined in Annex 10, Volume II, Chapter 1.1.*
Data transfer delay (95 percentile): defined in Annex 10, Volume III, Chapter 4.7.2.1.
Data transit delay: defined in Annex 10, Volume III, Chapter 4.7.2.1.
Ground earth station (GES): defined in Annex 10, Volume III, Chapter 1.
Near-geostationary orbits: defined in Annex 10, Volume III, Chapter 4.1.
Spot beam: defined in Annex 10, Volume III, Chapter 4.1.
Subnetwork layer: defined in Annex 10, Volume III, Chapter 6.1.
Subnetwork service data unit (SNSDU): defined in Annex 10, Volume III, Chapter 4.7.2.1

12.2 GENERAL

12.2.1 When an NGSS is operated to provide AMS(R)S, it shall conform to the requirements of this chapter.

12.2.1.1 **Recommendation**: *To ensure sufficient protection of safety-related CNS systems, NGSS aeronautical equipment not operating to provide AMS(R)S should comply with 12.3.2 and 12.3.3 of this Standard.*

12.2.2 Requirements for mandatory carriage of NGSS equipment including the level of system capability shall be made on the basis of regional air navigation agreements which specify the airspace of operation and the implementation time-scales for the carriage of equipment.

12.2.3 The agreements indicated in 12.2.2 shall provide at least two years' notice of mandatory carriage of airborne systems.

12.2.4 **Recommendation.**— *Civil aviation authorities should coordinate with national authorities and service providers those implementation aspects of NGSS that will permit its worldwide interoperability and optimum use, as appropriate.*

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* route

12.3 RF CHARACTERISTICS

12.3.1 Frequency Bands

Note.— ITU Radio Regulations permit systems providing mobile-satellite service to use the same spectrum as AMS(R)S without requiring such systems to offer safety services. This situation has the potential to reduce the spectrum available for AMS(R)S. It is critical that States consider this issue in frequency planning and in the establishment of national or regional spectrum requirements.

12.3.1.1 When providing AMS(R)S communications, the NGSS shall operate only in frequency bands in which AMS(R)S is permitted and appropriately protected by ITU Radio Regulations.

12.3.2 Emissions

12.3.2.1 The total EIRP of the AES necessary to maintain system performance shall be controlled to minimize the potential for interference to other systems. This requirement shall apply to single channel AESs, and to each individual channel of AESs that are capable of providing multiple channels.

12.3.2.2 Interference to other AMS(R)S Equipment

12.3.2.2.1 Emissions from an NGSS AES shall not cause harmful interference to an AES providing AMS(R)S on a different aircraft.

Note.— One method of complying with 12.3.2.2.1 is by limiting emissions in the operating band of other AMS(R)S equipment to a level consistent with the intersystem interference requirements (single entry) of Chapter 3.2.5.3.4.2 of RTCA Document DO-215A, Change 1.

12.3.2.3 INTERFERENCE TO OTHER CNS SYSTEMS

12.3.2.3.1 Emissions from an NGSS AES shall not cause harmful interference to non-AMS(R)S CNS systems located on the same aircraft or other aircraft.

Note.— Harmful interference can result from radiated and/or conducted emissions that include harmonics, discrete spurious, intermodulation product and noise emissions, and are not necessarily limited to the "transmitter on" state.

12.3.2.3.2 **Recommendation.**— *The average output spectral density of the composite of harmonics, discrete spurious and noise emissions created by the AES when transmitting at its maximum total output power should not be greater than -115 dBW/MHz in radio-navigation satellite service band 1 559 - 1 605 MHz, when measured at the input to the AES antenna over a period of 20 milliseconds.*

Note 1.— This recommendation assumes an isolation between the input to the AMS(R)S antenna subsystem and the output of the satellite navigation antenna subsystem of 40 dB and assumes an additional margin of 6 dB relative to the satellite navigation receiver susceptibility requirements established by the GNSS Panel.

Note 2.— Additional protection of radionavigation satellite services in the band of 1 605 - 1 609.36 MHz from the composite of harmonics, discrete spurious, noise and intermodulation products may be necessary for AES installations made prior to 1 January 2005.

12.3.3 Susceptibility

12.3.3.1 The AES equipment shall operate properly in an interference environment causing a cumulative relative change in its receiver noise temperature ($\Delta T/T$) of 25 per cent.

12.4 PRIORITY AND PREEMPTIVE ACCESS

12.4.1 The NGSS shall ensure that AMS(R)S communications are provided priority access to the radio channels over all non-AMS(R)S communications, by preemption if necessary.

12.4.2 The NGSS shall support at least three levels of AMS(R)S communications priority.

12.4.3 The system shall ensure that higher priority AMS(R)S communications are provided priority access to the radio channels over lower priority AMS(R)S communications, by preemption if necessary.

12.4.4 All AMS(R)S data packets and all AMS(R)S voice call attempts crossing the interface between a GES and a terrestrial network shall be identified as to their associated priority.

Note.— Some terrestrial networks, notably those implementing the 1984 version of X.25, may not offer sufficient support for the required prioritization.

12.4.5 Within the same message category, the system shall provide voice communications priority over data communications.

12.5 SIGNAL ACQUISITION AND TRACKING

12.5.1 The AES, GES and satellites shall properly acquire and track service link signals when the aircraft is moving at a ground speed of up to 1 500 km/h (800 knots) along any heading.

12.5.1.1 **Recommendation.**— *The AES, GES and satellites should properly acquire and track service link signals when the aircraft is moving at a ground speed of up to 2 800 km/h (1 500 knots) along any heading.*

12.5.2 The AES, GES and satellites shall properly acquire and track service link signals when the component of the aircraft acceleration vector in the plane of the satellite orbit is up to 0.6 g.

12.5.2.1 **Recommendation.**— *The AES, GES, and satellites should properly acquire and track service link signals when the component of the aircraft acceleration vector in the plane of the satellite orbit is up to 1.2 g.*

12.6 PERFORMANCE REQUIREMENTS

12.6.1 Satellite system service area

12.6.1.1 **Recommendation.**— *The NGSS should provide a satellite system service area of 100 per cent of the surface of the Earth.*

12.6.2 Failure Notification

12.6.2.1 In the event of a service failure, the NGSS shall provide timely predictions of the time, location and duration of any resultant outages until full service is restored.

Note.— Service outages may, for example, be caused by the failure of a satellite, satellite spot beam, or GES. The geographic areas affected by such outages may be a function of the satellite orbit and system design, and may vary with time.

12.6.3 AES Requirements

12.6.3.1 The AES shall support packet data service, or voice service, or both.

12.6.3.2 The AES shall meet the relevant performance requirements contained in 12.6.4 and 12.6.5 for aircraft in straight and level flight throughout the satellite system service area.

12.6.3.2.1 **Recommendation.**— *The AES should meet the relevant performance requirements contained in 12.6.4 and 12.6.5 for aircraft attitudes of +20/-5 degrees of pitch and +/- 25 degrees of roll throughout the satellite system service area.*

12.6.4 Packet data service performance

12.6.4.1 If the system provides AMS(R)S packet data service, it shall meet the standards of the following subparagraphs.

12.6.4.1.1 An NGSS providing a packet-data service shall be capable of operating as a constituent mobile subnetwork of the ATN.

Note.— In addition, an NGSS may provide non-ATN data functions.

12.6.4.1.2 DELAY PARAMETERS

Note 1.— The terms used with respect to packet data service performance are based on the definitions in ISO 8348 (first edition). In applying these definitions to the NGSS subnetwork layer, the word "network" and its abbreviation "N" in ISO 8348 are replaced by the word "subnetwork" and its abbreviation "SN", respectively, wherever they appear.

Note 2.— Subnetwork performance may depend on a number of factors, including intensity of communication traffic. The performance values given here apply during peak busy hours.

12.6.4.1.2.1 *Connection establishment delay.* Connection establishment delay shall not be greater than 50 seconds.

Note.— Connection establishment delay, as defined in ISO 8348, includes a component, attributable to the called subnetwork service user, which is the time between the SN-CONNECT indication and the SN-CONNECT response. This user component is due to actions outside the boundaries of the satellite subnetwork and is therefore excluded from the AMS(R)S specifications.

12.6.4.1.2.2 *Transit delay, from-aircraft, highest priority.* From-aircraft transit delay shall not be greater than 23 seconds for the highest priority data service.

12.6.4.1.2.3 *Transit delay, from-aircraft, lowest priority.* From-aircraft transit delay shall not be greater than 28 seconds for the lowest priority data service.

Note 1.— In accordance with ISO 8348, transit delay values are based on a fixed subnetwork service data unit (SNSDU) length of 128 octets. Transit delays are defined as average values.

Note 2.— In any particular AES, lower priority from-aircraft traffic may be subject to additional delay, depending on the amount and rate of from-aircraft traffic loading.

12.6.4.1.2. *Transit delay, to-aircraft, highest priority.* To-aircraft transit delay shall not be greater than 23 seconds for the highest priority data service.

12.6.4.1.2.5 *Transit delay, to-aircraft, lowest priority.* To-aircraft transit delay shall not be greater than 28 seconds for the lowest priority data service.

12.6.4.1.2.6 *Data transfer delay (95th percentile), from-aircraft, highest priority.* From-aircraft data transfer delay (95th percentile), shall not be greater than 40 seconds for the highest priority data service.

12.6.4.1.2.7 *Data transfer delay (95th percentile), from-aircraft, lowest priority.* From-aircraft data transfer delay (95th percentile), shall not be greater than 60 seconds for the lowest priority data service.

12.6.4.1.2.8 *Data transfer delay (95 percentile), to-aircraft, highest priority.* To-aircraft data transfer delay (95 percentile) shall not be greater than 25 seconds for the highest priority service.

12.6.4.1.2.9 *Data transfer delay (95th percentile), to-aircraft, lowest priority.* To-aircraft data transfer delay (95th percentile) shall not be greater than 30 seconds for the lowest priority service.

12.6.4.1.2.10 *Connection release delay (95th percentile).* The connection release delay (95th percentile) shall not be greater than 25 seconds in either direction.

12.6.4.1.3 INTEGRITY

Note.— Residual error rate includes the probability of undetected error, the probability of undetected loss of an SNSDU, and the probability of an undetected duplicate SNSDU.

12.6.4.1.3.1 *Residual error rate, from-aircraft.* The residual error rate in the from-aircraft direction shall not be greater than 10^{-6} per SNSDU.

12.6.4.1.3.2 *Residual error rate, to-aircraft.* The residual error rate in the to-aircraft direction shall not be greater than 10^{-6} per SNSDU.

12.6.4.1.3.3 *Connection resilience.* The probability of a subnetwork connection (SNC) provider-invoked SNC release shall not be greater than 10^{-4} over any one-hour interval.

Note. — Connection release resulting from GES-to-GES handover, AES log-off or virtual circuit preemption are excluded from this specification.

12.6.4.1.3.4 The probability of an SNC provider-invoked reset shall not be greater than 0.1 over any one-hour interval.

12.6.5 Voice service performance

12.6.5.1 If the system provides AMS(R)S voice service, it shall meet the requirements of the following subparagraphs.

12.6.5.1.1 CALL PROCESSING DELAY

12.6.5.1.1.1 *AES origination.* The 95th percentile of the time delay for a GES to present a call origination event to the terrestrial network interworking interface after a call origination event has arrived at the AES interface shall not be greater than 20 seconds.

12.6.5.1.1.2 *GES origination.* The 95th percentile of the time delay for an AES to present a call origination event at its aircraft interface after a call origination event has arrived at the terrestrial network interworking interface shall not be greater than 20 seconds.

12.6.5.1.2 The total allowable transfer delay within the AMS(R)S subnetwork on a circuit-mode channel shall not be greater than 0.485 second.

Note.— Total transfer delay for the AMS(R)S subnetwork is defined as the elapsed time commencing at the instant that speech is presented to the AES or GES and concluding at the instant that the speech enters the interconnecting network of the counterpart GES or AES. This delay includes vocoder processing time, physical layer delay, RF propagation delay and any other delays within the AMS(R)S subnetwork.

12.6.5.1.3 VOICE QUALITY

12.6.5.1.3.1 The voice transmission shall provide overall intelligibility performance suitable for the intended operational and ambient noise environment.

12.6.5.1.3.2 **Recommendation.—** *Due account should be taken of the effects of tandem vocoders and/or other analog/digital conversions.*

12.6.5.1.4 VOICE CAPACITY

12.6.5.1.4.1 The system shall have sufficient available voice traffic channel resources such that an AES- or GES-originated AMS(R)S voice call presented to the system shall experience a probability of blockage of no more than 0.01.

Note.— Available voice traffic channel resources include all preemptable resources, including those in use by non-AMS(R)S communications.

12.6.6 Security

12.6.6.1 The system shall provide features for the protection of messages in transit from tampering.

12.6.6.2 The system shall provide features for protection against denial of service, degraded performance characteristics, or reduction of system capacity when subjected to external attacks.

Note.— Possible methods of such attack include intentional flooding with spurious messages, intentional corruption of system software or databases, or physical destruction of the support infrastructure.

12.6.6.3 The system shall provide features for protection against unauthorized entry.

Note.— These features are intended to provide protection against spoofing and "phantom controllers".

12.7 SYSTEM INTERFACES

12.7.1 The NGSS shall allow subnetwork users to address AMS(R)S communications to specific aircraft by means of the ICAO 24-bit aircraft address.

12.7.2 The system shall annunciate a loss of communications capability within 30 seconds of the time when it detects such a loss.

Note.— Provisions on the allocation and assignment of ICAO 24-bit addresses are contained in Annex 10, Volume III, Appendix to Chapter 9.

12.7.3 Packet data service interfaces

12.7.3.1 If the system provides AMS(R)S packet data service, it shall provide an interface to the ATN.

Note.— The detailed technical specification related to provisions of ATN-compliant subnetwork service are contained in Section 5.2.5 and Section 5.7.2 of Doc 9705 — Manual of Technical Provisions for the Aeronautical Telecommunication Network.

12.7.3.2 If the system provides AMS(R)S packet data service, it shall provide a connectivity notification (CN) function.

12.7.4 Voice service interfaces

12.7.4.1 If the system provides AMS(R)S voice services, AES and GES voice signalling and service procedures shall interwork with external telephony networks through a signalling interface consisting of a standardized set of interworking telephony events that conform to a recognized international telephony interface standard.

End of new text.

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ATTACHMENT D to State letter AN 7/1.3.81-00/70

PROPOSED AMENDMENT TO ANNEX 10, VOLUME III, PART I, CHAPTER 4

(AMSS)

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AERONAUTICAL TELECOMMUNICATIONS

ANNEX 10
TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

VOLUME III — COMMUNICATION SYSTEMS

(PART I — DIGITAL DATA COMMUNICATION SYSTEMS)

. . .

CHAPTER 4. AERONAUTICAL MOBILE-SATELLITE SERVICE

4.1 DEFINITIONS AND DESCRIPTIONS OF CHANNEL TYPES; GENERAL; SYSTEM CAPABILITIES

4.1.1 Definitions and descriptions of channel types

. . .

4.1.2 General

4.1.2.1 When aeronautical mobile-satellite service (AMSS), using near-geostationary orbiting satellites, is installed and maintained in operation as an aid to air traffic services, it shall conform with the provisions of 4.1 to 4.10 or with the provisions of Annex 10, Volume III, Part I, Chapter 12.

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ATTACHMENT E to State letter AN 7/1.3.81-00/70

PROPOSED AMENDMENT TO ANNEX 10, VOLUME V, CHAPTER 4

(CHANNEL LABELLING VDL MODE 3)

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INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

AERONAUTICAL TELECOMMUNICATIONS

ANNEX 10
TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

VOLUME V
(AERONAUTICAL RADIO FREQUENCY SPECTRUM UTILIZATION)

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CHAPTER 4. UTILIZATION OF FREQUENCIES ABOVE 30 MHZ

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4.1.2.2 Until at least 1 January 2005, DSB-AM equipment specifically designed for 25 kHz channel spacing shall be safeguarded with respect to its suitability for the Aeronautical Mobile (R) Service (AM(R)S) except in those regions or areas where regional agreement permits the use of equipment specifically designed for 8.33 kHz channel spacing or for VDL Mode 3 when used for air-ground voice communications.

4.1.2.2.1 Requirements for mandatory carriage of equipment specifically designed for 8.33 kHz channel spacing shall be made on the basis of regional air navigation agreements which specify the airspace of operation and the implementation time-scales for the carriage of equipment, including the appropriate lead-time. ~~Such regional air navigation agreements shall not become applicable before 1 January 1998~~.

4.1.2.2.3. Requirements for mandatory carriage of equipment specifically designed for VDL Mode 3 shall be made on the basis of regional air navigation agreements which specify the airspace of operation and the implementation time-scales for the carriage of equipment, including the appropriate lead-time.

4.1.2.2.3.1. The agreement indicated in Section 4.1.2.2.3. shall provide at least two years' notice of mandatory carriage of airborne systems.

4.1.2.2.4. Until at least 1 January 2010, equipment specifically designed to the VDL Mode 3 SARPs shall be safeguarded with respect to its suitability for the AM(R)S.

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4.1.2.4 In regions where 25 kHz channel spacing (DSB-AM and VHF digital link (VDL)) and 8.33 kHz DSB-AM channel spacing are in operation, the publication of the assigned frequency or channel of operation shall conform to the channel contained in Table 4.1 (*bis*).

Note.— Table 4.1 (bis) *provides the frequency channel pairing plan which retains the numerical designator of the 25 kHz DSB-AM environment and allows unique identification of a 25 kHz VDL and 8.33 kHz channel.*

4.1.3 Frequencies used for particular functions

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Table 4-1 *(bis)*. Channelling/frequency pairing

Frequency (MHz)	*Time slot**	*Channel spacing (kHz)*	*Channel*
118.0000		25	118.000
118.0000	A	25	118.001
118.0000	B	25	118.002
118.0000	C	25	118.003
118.0000	D	25	118.004
118.0000		8.33	118.005
118.0083		8.33	118.010
118.0167		8.33	118.015
118.0250	A	25	118.021
118.0250	B	25	118.022
118.0250	C	25	118.023
118.0250	D	25	118.024
118.0250		25	118.025
118.0250		8.33	118.030
118.0333		8.33	118.035
118.0417		8.33	118.040
118.0500		25	118.050
118.0500	A	25	118.051
118.0500	B	25	118.052
118.0500	C	25	118.053
118.0500	D	25	118.054
118.0500		8.33	118.055
118.0583		8.33	118.060
118.0667		8.33	118.065
118.0750	A	25	118.071
118.0750	B	25	118.072
118.0750	C	25	118.073
118.0750	D	25	118.074
118.0750		25	118.075
118.0750		8.33	118.080
118.0833		8.33	118.085
118.0917		8.33	118.090
118.1000		25	118.100
etc.			

* *Note. — Time slot indication is for VDL Mode 3 channels. (Ref. Annex 10, Volume III, Part I, Chapter 6 for characteristics of VDL Mode 3 operation)*

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4.1.3.1.6. The emergency channel (121.5 MHz) shall be available only with the characteristics as contained in Annex 10, Volume III, Part II, Chapter 2.

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4.1.3.2.1 In remote and oceanic areas out of range of VHF ground stations, the air-to-air VHF communications channel on the frequency 123.45 MHz shall be available only with the characteristics as contained in Annex 10, Volume III, Part II, Chapter 2.

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4.1.3.3 Common signalling channel. The frequency 136.975 MHz is reserved on a world-wide basis to provide a common signalling channel (CSC) to the VHF digital link (VDL) for VDL Mode. This CSC uses the Mode 2 VDL modulation scheme and carrier sense multiple access (CSMA).

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4.1.4.2. The auxiliary search and rescue channel (123.1 MHz) shall be available only with the characteristics as contained in Annex 10, Volume III, Part II, Chapter 2.

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4.1.8 Plan of assignable VHF radio frequencies for use in the international aeronautical mobile service

Introduction

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Where all the channels of Groups A, B, C, D and E of the lists in 4.1.8.1.2 below are insufficient to meet the requirements of a region, a part or parts of the band may be designated as containing 8.33 kHz width channels or designated as supporting VDL Mode 3. For parts of the band containing 8.33 kHz width channels, ~~and~~ the appropriate frequencies from Group F should be used in accordance with 4.1.8.1.1.1 and 4.1.8.1.2. It should be noted that the designation of frequencies in Group F differs from that of the corresponding frequencies in Groups A to E to emphasize the difference in channel width. For part of the bands supporting VDL Mode 3, frequencies from Groups A, B, C, D and E are utilized on a time-division basis. A single frequency supports multiple channels, each utilizing the frequency in periodic time frames or time slots. Specific time slots for VDL Mode 3 are identified using the numeric designators of Table 4-1 (bis).

Although for Group F a preferred order of selection is not indicated, regional planning may require a particular selection of frequencies from this group in order to cater for specific regional circumstances.

In many regions particular frequencies have already been assigned for particular functions as, for instance, aerodrome or approach control. The plan does not make such assignments (except in respect to the emergency channel and ground service frequencies), such action being taken regionally if considered desirable.

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4.1.8.1.1.1 When the number of frequencies required in a particular region exceeds those available in Groups A to E of 4.1.8.1.2 below, parts of the band shall be designated as containing 8.33 kHz width channels (voice) or as containing VDL Mode 3. ~~; and~~ A ~~a~~ appropriate frequencies shall be selected from Group F of 4.1.8.1.2 below for 8.33 kHz channel assignments or from Groups A to E in accordance with the time-slot assignments in accordance with Table 4-1(bis) for VDL Mode 3. The remainder of the band shall continue to be used for 25 kHz width channels selected from the appropriate parts of Groups A to E.

Note 1.— The frequencies 121.425 - 121.575 MHz inclusive, 123.075 - 123.125 MHz inclusive and 136.500 - 136.975 MHz inclusive are not available for assignment to channels of less than 25 kHz width.

Note 2.— Services that continue operation using 25 kHz assignments will be protected in regions implementing 8.33 kHz channel spacing.

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ATTACHMENT F to State letter AN 7/1.3.81-00/70

PROPOSED AMENDMENT TO ANNEX 10, VOLUME III, PART II, CHAPTER 4

(ATS SPEECH CIRCUITS)

NOTES ON THE PRESENTATION OF THE AMENDMENT TO ANNEX 10

The text of the amendment is arranged to show deleted text with a line through it and new text highlighted with grey shading, as shown below:

1. ~~Text to be deleted is shown with a line through it.~~	text to be deleted
2. New text to be inserted is highlighted with grey shading.	new text to be inserted
3. ~~Text to be deleted is shown with a line through it~~ followed by the replacement text which is highlighted with grey shading.	new text to replace existing text

INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

AERONAUTICAL TELECOMMUNICATIONS

ANNEX 10
TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

VOLUME III — COMMUNICATION SYSTEMS

(PART II — VOICE COMMUNICATION SYSTEMS)

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CHAPTER 4. AERONAUTICAL SPEECH CIRCUITS

4.1 TECHNICAL PROVISIONS RELATING TO INTERNATIONAL AERONAUTICAL SPEECH CIRCUIT SWITCHING AND SIGNALLING FOR GROUND-TO-GROUND APPLICATIONS

Note.— Guidance material on aeronautical speech circuit switching and signalling for ground-to-ground applications is contained in ~~ICAO Circular 183.~~ the Manual on Air Traffic Services (ATS) Ground Voice Networks.

4.1.1 The use of circuit switching and signalling to provide ~~point-to-point~~ speech circuits to interconnect ~~area control centres~~ ATS units not interconnected by dedicated circuits shall be by agreement between the Administrations concerned.

4.1.2 The application of aeronautical speech circuit switching and signalling shall be made on the basis of regional air navigation agreements.

4.1.3 **Recommendation.**— ~~*Where implemented, aeronautical speech circuit switching and signalling should provide:*~~

~~*a) priority access;*~~

~~*b) automatic call-back;*~~

~~*c) conference calling;*~~

~~*d) through switching facilities;*~~

~~*e) the capability of alternate routing, when necessary and feasible;*~~

~~*f) identification of originator for incoming calls, when necessary and feasible; and*~~

~~*g) call forwarding, when necessary and feasible.*~~

~~*Note 1.— Identification of originator is done by analysis of the originator's code which is transmitted on both signalling systems R2 and No. 5.*~~

~~*Note 2.— Call forwarding ensures that calls to operating positions which are temporarily not manned will be rerouted automatically to an appropriate operating position.*~~ *The ATC communication requirements defined in Annex 11, Section 6.2 should be met by implementation of one or more of the following basic three call types:*

a) instantaneous access;

b) direct access; and

c) indirect access.

Note.— Definition of these terms, including performance parameters and guidance for implementation, are contained in the Manual on Air Traffic Services (ATS) Ground Voice Networks.

4.1.4 **Recommendation.**— ~~*The characteristics of signalling tones used in aeronautical speech circuit switching and signalling should conform to ITU CCITT Signalling System No. 5 or to ITU CCITT Signalling System R2 as appropriate. Signalling tones on interregional trunks should conform to one of these ITU CCITT specifications as determined by agreement between the Administrations concerned.*~~

~~*Note.— Details of ITU CCITT Signalling System No. 5 are contained in CCITT Yellow Book, Volume VI — Fascicle VI-2; details of ITU CCITT Signalling System R2 are contained in CCITT Yellow Book, Volume VI — Fascicle VI-4.*~~ *In addition to the ability to make basic telephone calls, the following functions should be provided in order to meet the requirements set out in Annex 11:*

a) means of indicating the calling/called party identity;

b) means of indicating urgent/priority calls; and

c) conference capabilities.

Note.— Definitions of these terms, including performance parameters and guidance for implementation, are contained in the Manual on Air Traffic Services (ATS) Ground Voice Networks.

4.1.5 **Recommendation.**— *The characteristics of the ~~ringing tone, the busy tone and the congestion tone~~ circuits used in aeronautical speech circuit switching and signalling should conform to ~~ITU CCITT Recommendation E.180.~~ appropriate ISO/IEC international standards and ITU-T recommendations.*

~~*Note.— Details of ITU CCITT Recommendation E.180 are contained in CCITT Yellow Book, Volume H — Fascicle H-2.*~~

Note.— References to, and other material on, the relevant ISO/IEC standards and ITU-T recommendations are contained in the Manual on Air Traffic Services (ATS) Ground Voice Networks.

4.1.6 **Recommendation.**— ~~*The numbering plan used in aeronautical speech circuit switching and signalling should consist of six digits whereby the first two digits identify the area, the third and fourth digits the control centre and the fifth and sixth digits the working position or correspondent within the control centre. Up to two additional digits may be added following the sixth digit to allow a larger number of positions within a control centre to be uniquely addressed.*~~

~~*Note.— The area identifier may be used to identify either a country or a group of countries.*~~ *Digital signalling systems should be used wherever their use can be justified in terms of any of the following:*

a) improved quality of service;

b) improved user facilities; or

c) reduced costs where quality of service is maintained.

Note.— Guidance material on the use of digital and analogue signalling systems is contained in the Manual on Air Traffic Services (ATS) Ground Voice Networks.

4.1.7 **Recommendation.**— ~~*It should not be necessary to dial the area identifier code on calls between stations sharing a common area identifier.*~~ *The characteristics of supervisory tones to be used (such as ringing, busy, number unobtainable) should conform to appropriate ITU-T recommendations.*

Note.— References to, and other material on, the relevant ITU-T recommendations are contained in the Manual on Air Traffic Services (ATS) Ground Voice Networks.

4.1.8 **Recommendation.**— *To take advantage of the benefits of interconnecting regional and national aeronautical telephone networks, the international aeronautical telephone network numbering scheme should be used.*

Note.— Details of this numbering scheme, together with guidance on migration from existing numbering schemes to the new scheme, are contained in the Manual on Air Traffic Services (ATS) Ground Voice Networks.

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